SCIENTIFIC AMERICAN

September 1929 35¢ a Copy

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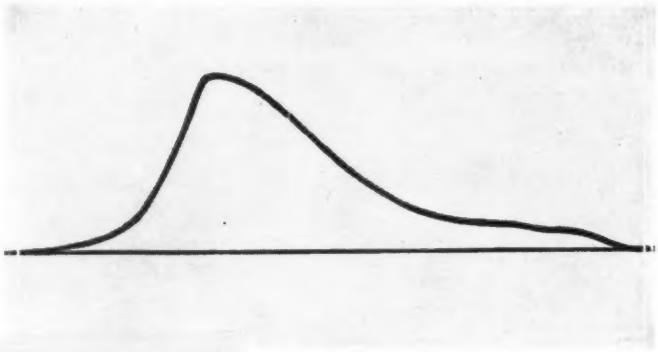
SILVERING LARGEST TELESCOPE MIRROR

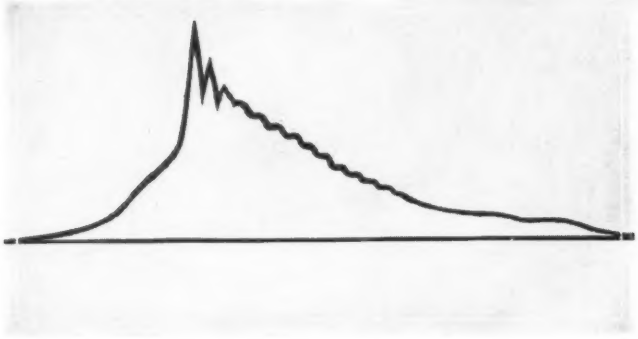
IS THE AIRPLANE DIESEL PRACTICAL?

STEAM VERSUS WATER POWER

What is that "KNOCK"?

This is what happens in the cylinder of a gasoline engine when it is running smoothly. The pressure gradually increases after ignition until the mixture is nearly all burned. Then it grows less and less.





But when the gasoline is causing the engine to "knock," just see what happens. Is it any wonder that the engine loses power? Ethyl Gasoline prevents that jagged saw-tooth by "knocking out that knock."

THE "knock" was a mystery in the automotive world until the scientists in General Motors Research Laboratories started on its trail. Before they finished they not only found out what that elusive "knock" was, but were actually able to take a picture of it!

This was made possible by the development of the Midgley Indicator, which records the pressure inside the cylinder of a gasoline engine. It was this ingenious device which first revealed the truth—that the "knock" was caused not by the engine, but by inherent faults in gasoline itself.

It showed that gasoline, when compressed beyond certain limits, explodes too fast—that is, "knocks" and loses power. Then the problem was to find something to mix with gasoline to control its combustion rate as compression was raised. After years of research it was found that Ethyl fluid, containing tetraethyl lead, was the solution.

Today leading oil companies mix Ethyl fluid with their gasoline to form Ethyl Gasoline. Ethyl made possible the engines of higher compression now on the market. By eliminating "knock" in engines of average compression it brings out additional power, gives them a new resiliency and nimbleness impossible to obtain with ordinary gasoline. Ride with Ethyl.

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ETHYL GASOLINE

Knocks out that "knock"

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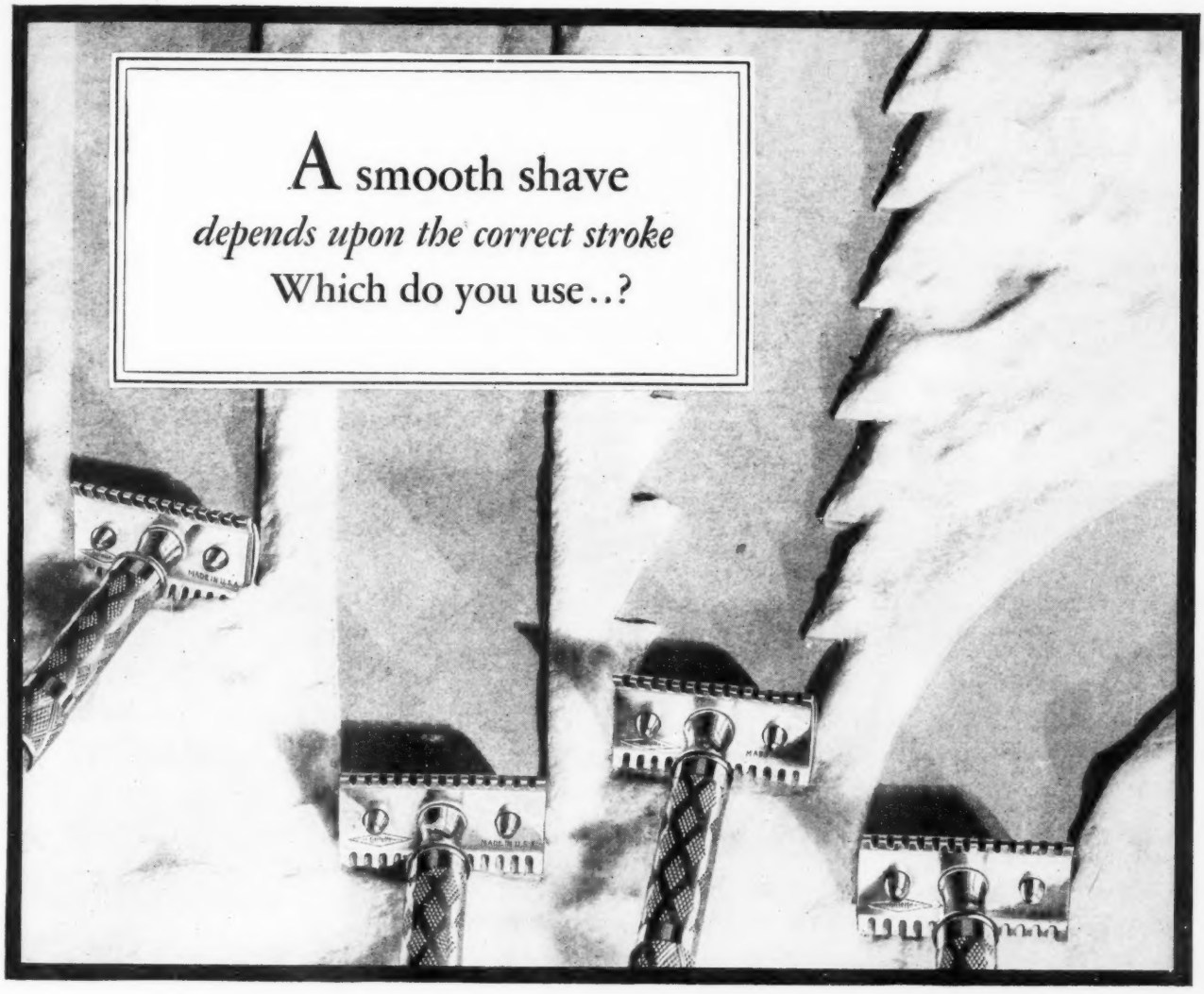


EIGHT out of ten American men shave with a Gillette Razor, and probably not more than half of them use the correct diagonal stroke shown at the extreme left.

But they all judge a shave on its face value, and they find the value *there*, in every Gillette Blade, no matter what stroke they happen to use. Gillette has put it there—designed the blade to meet all possible changing conditions.

In the past ten years the Gillette plant has invested $12,000,000 in blade improvements alone. Today the work is done by amazingly skilful machines—adjusted to one ten-thousandth of an inch. And the product of these machines is tested and re-tested by a long line of inspectors who get a bonus for every blade they discard.

Tomorrow morning slip a fresh Gillette Blade into its holder. Lather well and use the correct diagonal stroke. Let the world's best blade in the world's best razor give you the best of all possible shaves. Gillette Safety Razor Co., Boston, U. S. A.

THE only individual in history, ancient or modern, whose picture and signature are found in every city and town, in every country in the world, is King C. Gillette.

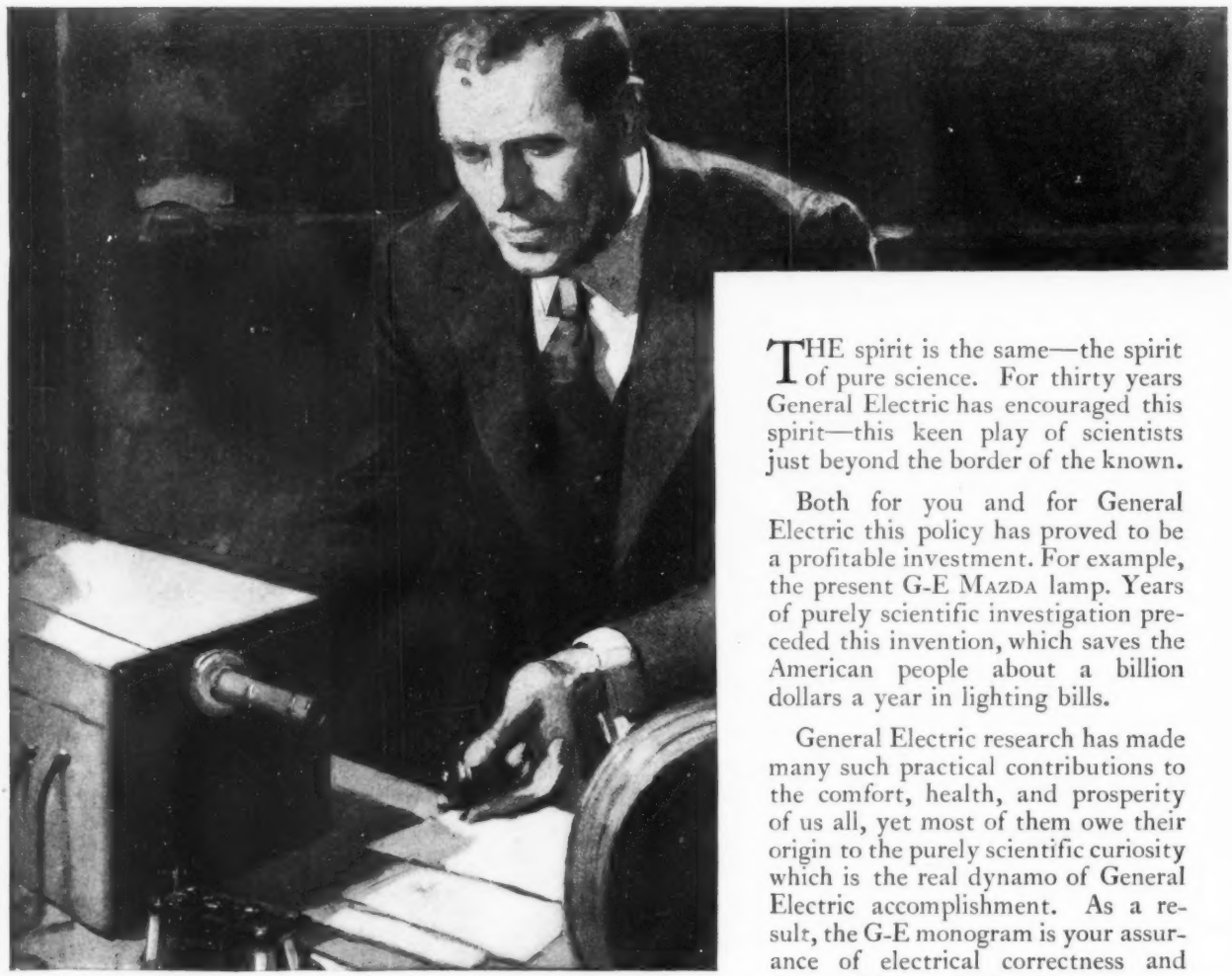
This picture and signature are universal sign-language for a perfect shave.

Gillette

Gillette

WHAT MAKES IT TICK?

The boy takes his birthday watch apart to see what makes it tick. The boy grown older listens to the tick of uranium electrons discharged into space—he actually hears *the atoms of the metal disintegrate.*



THE spirit is the same—the spirit of pure science. For thirty years General Electric has encouraged this spirit—this keen play of scientists just beyond the border of the known.

Both for you and for General Electric this policy has proved to be a profitable investment. For example, the present G-E MAZDA lamp. Years of purely scientific investigation preceded this invention, which saves the American people about a billion dollars a year in lighting bills.

General Electric research has made many such practical contributions to the comfort, health, and prosperity of us all, yet most of them owe their origin to the purely scientific curiosity which is the real dynamo of General Electric accomplishment. As a result, the G-E monogram is your assurance of electrical correctness and dependability, whether it appears on the motor that runs your sewing machine or on those that drive great liners out to sea.

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COVER

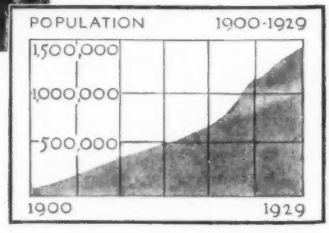
The thick, slightly concave disks of glass used as light gatherers in reflecting telescopes are nothing but mechanical supports for the real mirror—a film of metallic silver about one hundredth the thickness of tissue paper, deposited chemically on the front of the glass. This month, as explained in the descriptive article on page 225, two artists have cooperated to depict this interesting process.

Industry follows population
to LOS ANGELES COUNTY

50%
of the Pacific Coast States' added

POPULATION

during the last 8 years, have settled here!



Population density has brought to Los Angeles County more factories, producing over double the output, than the next largest Pacific Coast County. With 40% of Coast population in Southern California, local industries enjoy a large home market, and economical distribution by truck, rail or water to Western States and foreign countries.

New industries will find: Adequate, contented labor; low building costs; good factory sites; low-cost power, natural gas and oil fuel and abundant water. Airplane mail and commercial service is more than one-third of the national daily total.

For specific information kindly address—

Industrial Department

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Looking Ahead *With the* Editor

October—Aviation Number

AVIATION is rapidly finding its stride but the time is still far distant when we may accept its advances with any great degree of matter-of-factness. There is a large element of novelty in the Autogiro, for example, which puzzles many; airport design problems are still largely unsolved; dirigibles—particularly those ordered for our Navy—are thought by some to be impracticable and by others, the most efficient form of aircraft; youngsters want to fly but have little knowledge of good air schools and, of course, parents want their boys to attend the best; and many see in the new Packard Diesel engine for airplanes the greatest advance of the year. Our October Aviation Number will include articles on as many of these subjects as possible while the remaining ones will be held over for future issues. In October also, will be an article on the airlines of the United States by Professor Klemin, one on the industrial and financial aspects of aviation, and last but not least, one about the interesting air experiences of a friend of yours who has been called the "Patron Saint of Aviation": Will Rogers.

England's Ancient Flint Mines

JUST as we mine our metals to keep our industries going, ancient man in England mined flints from which to fashion his tools. The site of these mines and the nearby workshops is one of the most important prehistoric areas so far discovered in England, according to the scientist who writes of them in an early issue.

The Keenest Edge is Jagged

JUST how saw-tooth-like *must* your razor blade be to give you the best shave? Your face doesn't know but a scientist who has made an intensive study of the question does. In a forthcoming article he will tell you some very surprising facts about your razor blade and show micro-photographs of good and bad edges.

Have We a Naval Yardstick?

AFTER years of discussion, there is at last a ray of hope for definite reduction of existing and projected naval armaments. An article now ready for release discusses past limitations attempts, from the abortive one of 1898, initiated by Russia, to the recent meeting of the Preparatory Commission at Geneva; and explains our present stand as stated by Mr. Gibson.

Every Issue Fully Illustrated

¶ *The well-informed man or woman is the one who progresses. Why not let the* SCIENTIFIC AMERICAN *bring to you the latest news of the scientific world in general? The cost is nominal—only four dollars for an entire year's subscription.*

Among Our Contributors

Major Levin H. Campbell, Jr.

Having served as a Captain in the Coast Artillery Corps, Major Campbell was transferred to the Ordnance Department in 1918. With the rank of Major, he has been, since 1919, directly connected with the design, manufacture, and test of Army automotive equipment. He also spent a year in the shops of a large tractor company undergoing practical instruction. Thus he has a rare knowledge of tanks, and other automotive equipment that has assumed a position of such importance in the Army's mechanization plans.

R. W. Porter

Twelve times Mr. Porter, one of our corresponding editors, was in the far north with Peary, Fiala, and others as astronomer, surveyor, and artist. Two winters he spent under starvation conditions with the Ziegler Expedition when its ship was crushed in the ice. As he is a natural born mechanic with a love for optics, it is not unnatural that astronomy led him into telescope making.

R. M. Boykin

Of late years there has been much discussion of the momentous question of steam versus water-power for the generation of electricity. With his article in this issue, Mr. Boykin steps boldly into the argument with some convincing facts. And well he may, for he is President of the Northwestern Electric Light and Power Association, is Manager of the Seattle office of the Puget Sound Power and Light Company, and has made a long study of this question.

J. Reid Moir

A business man, Mr. Moir turned amateur scientist in 1909. The flints he found and claimed were of pre-glacial make, were not widely accepted until, in 1923, there came full recognition when an international commission of scientists pronounced them genuine. By scientists he is now regarded as a professional. His archeological explorations range from the pre-glacial to the Iron Age.

NORTHWEST AT 125 MILES AN HOUR!

Features of Ford Plane

All-metal (corrugated aluminum alloys)—for strength, uniformity of material, durability, economy of maintenance, and structural safety . . .

Tri-motored (Wright or Pratt & Whitney air-cooled engines, totaling from 900 to 1275 horsepower)—reserve power for safety.

Speed range—55 to 135 m. p. h. Cruising radius, 580-650 miles.

Disposable load—3670 to 5600 pounds.

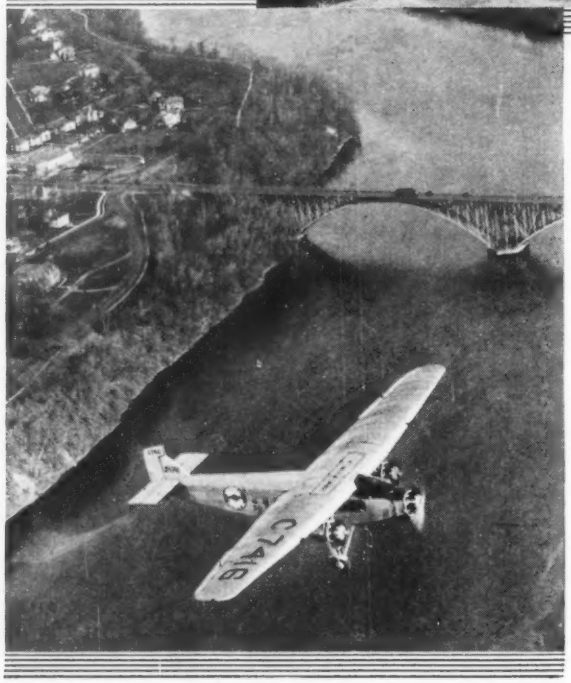
High wing monoplane (single, stream-lined, cantilever wing)—for strength, speed, inherent stability, visibility, clean design . . .

17 *capacity* (including pilot's dual-control cabin)—Buffet, toilet, running-water, electric lights, etc.

Durability—No Ford plane has yet worn out in service.

Price, $42,000 to $55,000 (standard equipped at Dearborn)—Exceptionally low because of multiple-unit on-line production methods.

Air passengers entering Northwest Airways Ford plane at Cicero Field, Chicago. Time, 3 P. M. They will be in Twin Cities, after a smooth, safe, glorious flight, at 6.40 P. M.! Modern air fields line the entire route.



Above the Twin Cities after gliding high in the air across some of the most beautiful and romantic country in America.

SPEED is an important consideration . . . but it is only one of many reasons that have made the Northwest Airways one of the most successful transportation companies in America, whether by land or sea or air.

This service, flying the skyways between Chicago and Twin Cities, was inaugurated in 1926, and has been in operation ever since, carrying mail, fast express and passengers. *95% of scheduled flights were completed!*

Latest model Ford all-metal, tri-motored planes are now in regular service on the Northwest Airways. These big machines, with great reserve power, have three motors, developing 1275 horse-power! With twelve passengers and pilots, they can maintain a comfortable speed of over 100 miles an hour, and reach a maximum speed of 135 miles an hour. *With only one engine turning, each of these planes may extend its gliding range for many miles. Landing fields are always within gliding distance.*

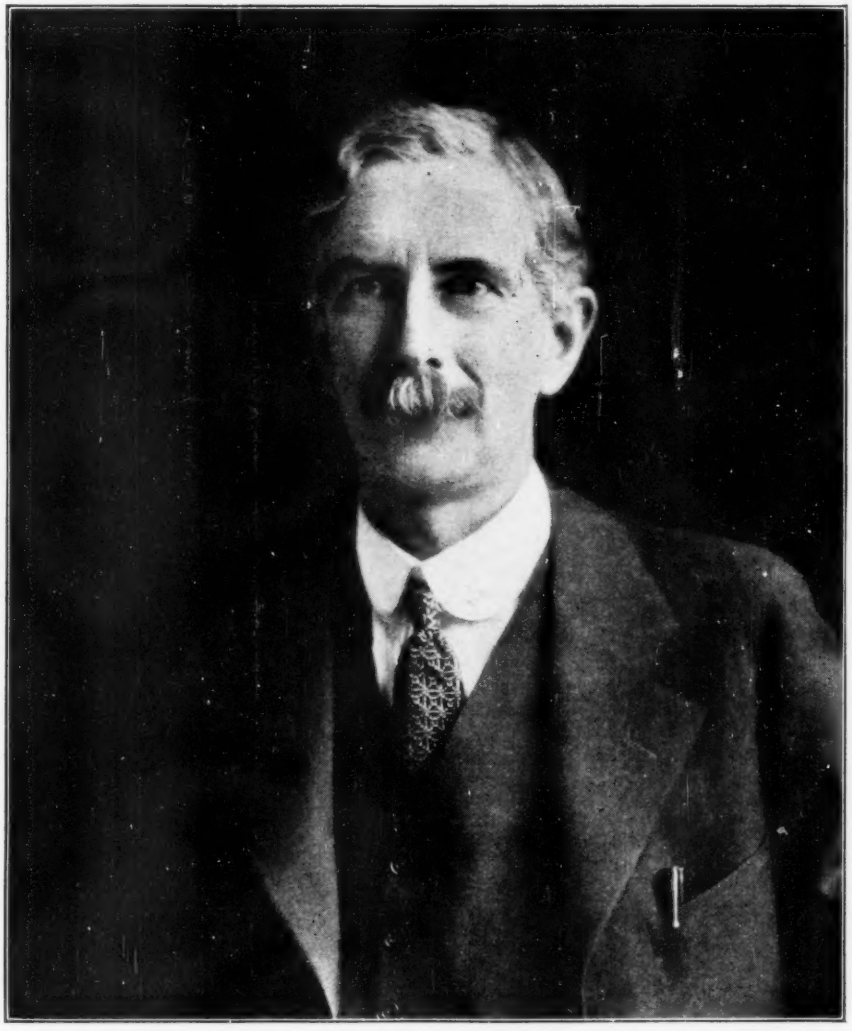
All planes are delightfully furnished and decorated. Travelers are provided with every comfort, including a lavatory with running-water; so that this swift passage across the sky may be enjoyed in mental and physical relaxation.

The Northwest Airways pioneered in the establishment of co-ordinated air-rail service in this country. Connection is made with six railroads, three of which operate from the West and Northwest and three from the East.

Ford all-metal, tri-motored planes have been put into service over this great skyway not only because the air-minded American public recognizes them as safe and dependable commercial air transports, but also because they have proved so highly efficient in all sorts of service.

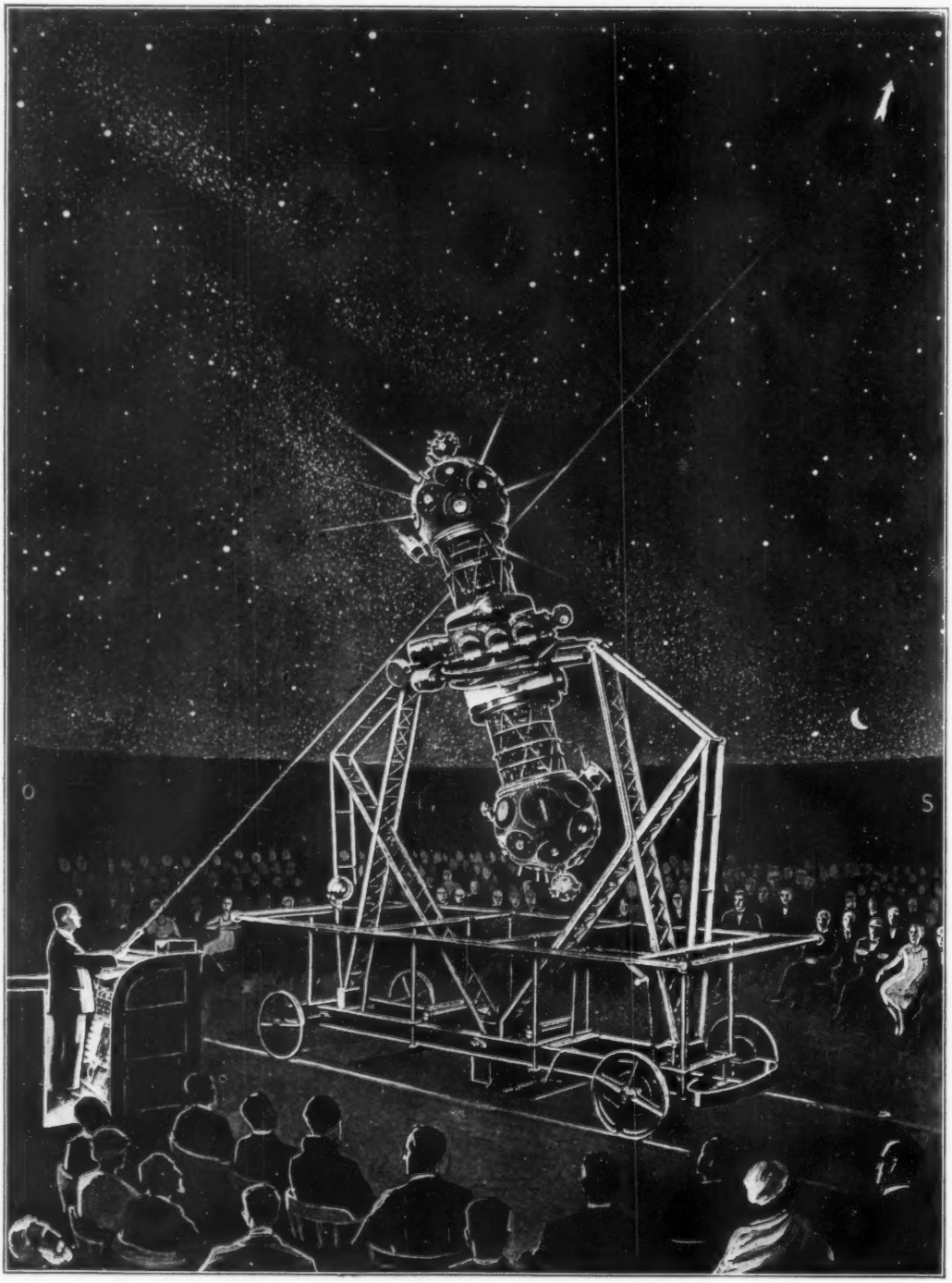
Visitors are always welcome at the Ford Airport at Detroit.

FORD MOTOR COMPANY



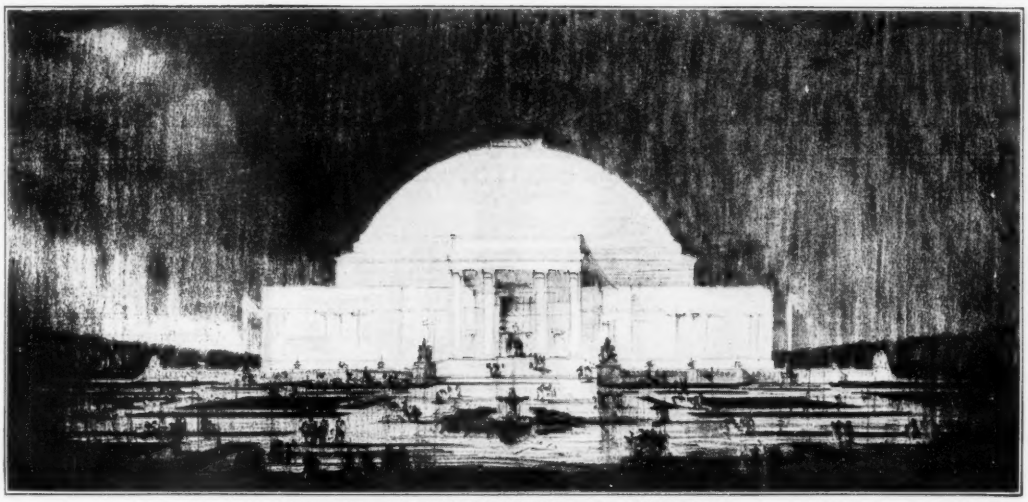
Charles G. Abbot

"SOLAR physics; infra-red solar spectrum; solar constant of radiation; variability of the sun and of terrestrial temperature; utilization of solar heat." "American Men of Science" thus lists unusual corners of science in which runs the career of the distinguished scientist whose photograph appears above. Obviously they center around the study of the sun. In 1928, Dr. Abbot was placed at the head of the famous Smithsonian Institution. Despite the demands of this administrative position he continues his research. He has proved that the sun is a variable star like many others of the stars, and he has published evidence indicating that the earth's climate varies consequently in a predictable manner. Dr. Abbot has written, among other books, "The Sun," recently revised, and "The Earth and the Stars." Both treat of the sun from many aspects, especially as the earth's heat source; also of solar engines for power purposes. Dr. Abbot has invented several instruments widely used. His solar cooker and his fly-wing star radiometer for measuring the heat of the stars are celebrated.



The Planetarium, and the Lecturer Using an Electric Pointer

AS we enter the rotunda a white dome spreads over our heads. The white dome presently dims and vanishes into a light blue canopy above. A mysterious silence descends upon the spectators. The sun and his family, and the moon, appear in the sky. The faint humming of the motors is heard. The stars begin to execute their diurnal motion. The sun sets, and the starry heavens burst into radiance. All this is magically produced by the projector shown



THE NEW PLANETARIUM FOR CHICAGO

Max Adler, a former Sears-Roebuck official, generously gave Chicago 500,000 dollars to purchase a Zeiss planetarium for that city. It will be on an island near the Field Museum. Samuel S. Fels, philanthropist, has just provided a planetarium for Philadelphia, and other cities have become interested

Canned Astronomy

What the New Planetariums for Chicago and Philadelphia Will Be Like

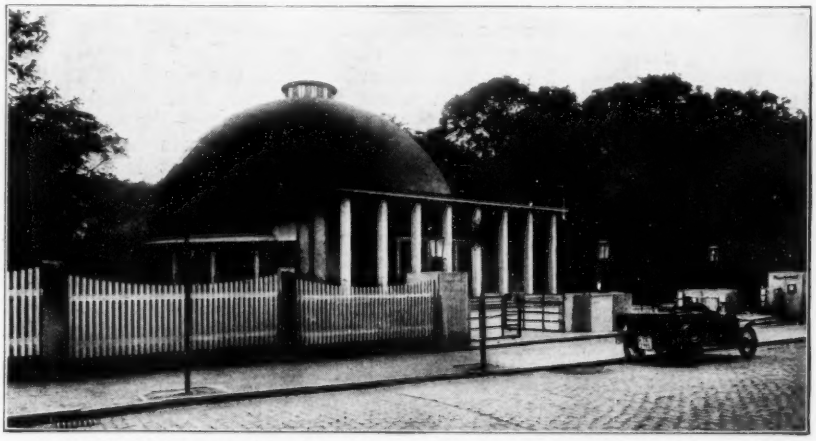
By ALBERT G. INGALLS

WITHIN the year Chicago and Philadelphia are to have the first American planetariums — Chicago on a small island near the famous Field Museum; Philadelphia as a part of the new Science Museum of the Franklin Institute. From the day of opening of these two mechanical marvels, public interest in planetariums is certain to reach a new level all over the nation.

It is said that no one ever sees a planetarium without wishing there was one in his own community. Certain it is that no one of scientific turn of mind has ever been known to leave a planetarium performance disappointed. It is one of the things that really outdo expectation. People who go to one, hoping thus to disentangle their mental misconceptions regarding the complicated relations and motions of the heavenly bodies, find that they have not only been instructed but entertained. For the planetarium is a good show. Even a person without the least scientific interest in astronomy would find it so. Intrinsically the performance is esthetic. It provides thrills while it educates.

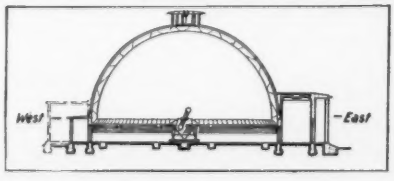
You can not adequately describe this performance; you must see it. As a controlled mechanical reproduction of the universe, with the mechanics in the background, it is well nigh perfect. The sun sets like the real sun. Twilight fades into night as smoothly as Nature's twilight. And the night—what a night! Except in the desert you will not see such nights—certain it is that you will never see the stars so clearly in any city. Your first impulse on emerging from the planetarium will be to send a telegram back home stating that your city *must* have one at once; and you will begin as soon as you are home from Chicago or Philadelphia, making appointments to see influential people in the interest of acquiring one of these miracles for your city. Education alone will justify the purchase. Even though the price is high, some 75,000 dollars for the projector without the building, you will want your own community to have one.

At present the only way to see a planetarium is to go to Europe, especially Germany where they were invented and developed, and where they are made. Fifteen German cities now

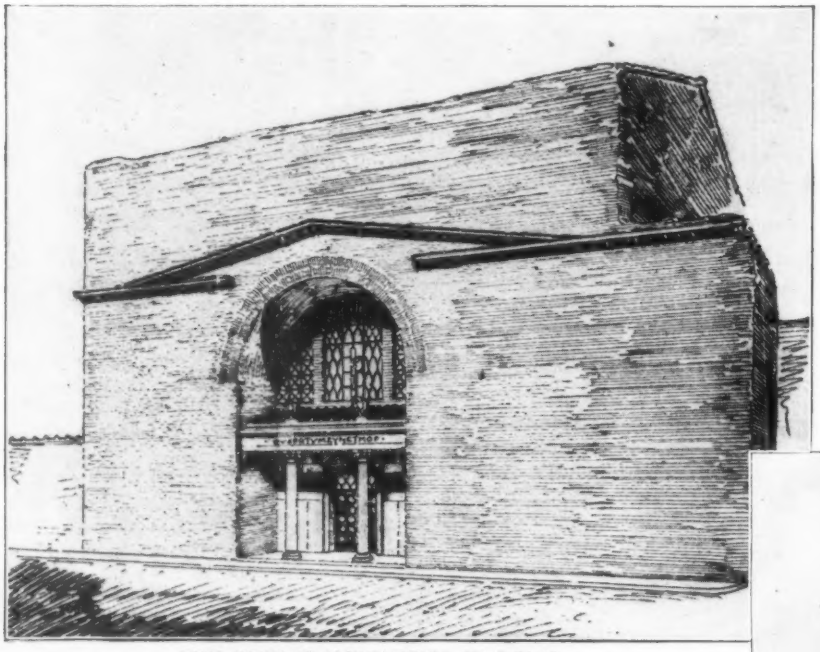


PLANETARIUM IN JENA

It was here that the performance described in the article was witnessed. The dome is of sprayed concrete on a fabricated webbing of iron rods. The outside covering of concrete is thinner, in proportion, than the shell of an egg. Inside of this thin dome a light skeleton supports the acoustic baffle plates shown in another picture, and the linen projection screen



own planetariums. So also do Vienna, Rome, and Moscow. People, old and young, stand nightly in long queues waiting for the performance to begin. It "goes over big." Within eight months after the first of the new planetariums was installed in Jena, Germany, 78,000 visitors came to have their concepts of the heavens straightened out; 110,000 came in a year. And Jena is a small city. In nearly every case, in Germany, the planetariums are owned by the community. Putting the stars into politics!



THE NEW PLANETARIUM IN ROME

Mussolini decreed that the ancient and modern should be combined, and allotted to the planetarium the Hall of Minerva. A light hemisphere is constructed inside it

That old German city of Jena, once famous as the home of Goethe and Schiller and the philosophers Hegel and Fichte, is now the center of gravity of European optics. Its vast Carl Zeiss optical works is more than a commercial firm, it is a scientific institution. Decades ago its advanced methods of sharing both profits and confidence with its workmen became famous. A day in Jena will be well spent if one has a scientific turn of mind. Much will be learned.

OF course, the planetarium is not a new thing—not in its essence. There have been planetariums since Huyghens first made apparatus for duplicating the motions of the planets. Indeed, an orange revolved around a lamp by a school teacher is a planetarium. But the German invention is so far ahead of anything previously conceived that few, certainly not those who have seen it in operation, will cavil when it is called "the" planetarium.

One enters a large dome. Geometrically it is a hemisphere. An ant would feel the same under the peel of a half orange. The planetarium dome is usually about 75 feet in diameter. If much smaller there are certain optical drawbacks, but if much larger the cost of the structure will be increased out of proportion to its usefulness. A 75-foot dome will seat an audience of 600.

This dome represents the sky, the vault of heaven. Before the lights go out and the heavens are flashed on, one feels as one always feels when in a building—an "inside" kind of a feeling. Shortly, when the lights are dimmed and out and the planetarium spectacle is on, one will acquire an outside feeling—the confining dome retreats to infinity. Thus perfect is the verisimilitude. The dome seems to vanish by magic.

Just about at this time the audience always says "Ah!" You can hear it ripple across the room and back, a genuine kind of an "Ah." They say that it is an invariable, spontaneous, and insuppressible accompaniment of this first glimpse of the "heavens," when the stars are flashed on. Even a case-hardened professional astronomer will say it under his breath.

How many stars do you see out of doors on the clearest night? Few who do not already know guess right. Many guess in millions. The actual count of naked-eye stars in a clear sky gives less than 3000. The planetarium heavens have the full quota of naked eye stars. And they look like the stars. How is this perfect illusion brought about? What was it that made the curved dome of the building, nowhere more than a few feet away, suddenly traverse light-years outward in all directions when the lights were turned off and the demonstration started? How would you go about equipping a domed ceiling with 5400 stars—those of two hemispheres—so that they would not seem artificial to the visitor?

A not unnatural conclusion would be, tiny electric lamps attached to the under side of the dome. But at best that would provide only a crude illusion. Then is it holes of various diameters in the dome, all illuminated from behind? Such a method, which has been tried, works better but it lacks just one thing—real illusion. No, the whole 5400 stars are projected from the odd-appearing apparatus in the center of the floor.

For a moment let us study the "close-up" illustration this contraption, this giant "dumb bell" with its 119 optical projectors. On either end of it there is a sort of hemisphere, which looks not unlike a diver's helmet. Within each of these "helmets" is a powerful incandescent lamp. Set into the sides in various positions are 16 lenses. Behind each lens is a kind of diaphragm bearing the right stars in the right places. These project slender invisible pencils of light, corresponding to each star,

HANNOVER'S PLANETARIUM

Atop the offices of the *Hannoverischer Anzeiger*. No doubt that newspaper receives enough valuable publicity from it to justify the initial investment

to the inner walls of the dome of the planetarium. At first glance one might be excused for objecting that the picture shows there are not enough lenses fully to cover the sky. But the concavity of the lenses, as precalculated, takes care of any such discrepancy. Thus there is no overlapping of images, no blurring; nothing is crude, and the illusion is carried out with typical Teutonic thoroughness.

But why must there be two of these "helmets?" one asks. The answer is, to permit the apparatus to project not only the stars of the northern hemisphere but also those of the southern. In the planetarium one travels; indeed, before we have seen the complete performance we shall see things no man has ever seen in reality or ever will see. We shall take the universe to pieces. Some of the effects thus produced are bizarre.

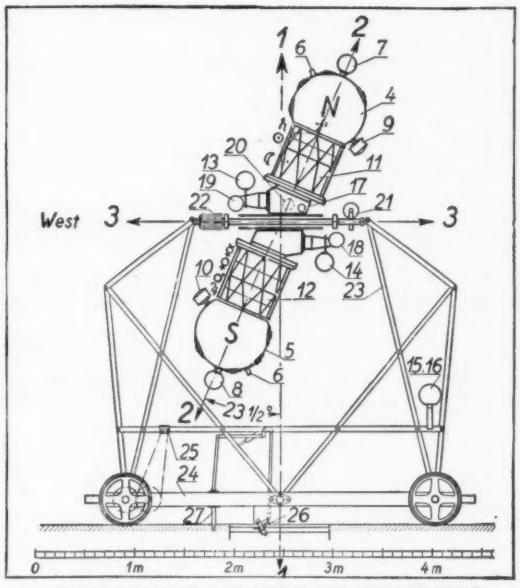
IN addition to the 5400 stars down to the 6.2 magnitude the planetarium projects the Milky Way. This is projected separately from little gadgets on the side of the apparatus. These are shown at 9 and 10 in the longitudinal section drawing.

Now, all these things are not merely projected inertly on the interior of the dome; they move. To accomplish this it is simply a matter of rotating the helmets. A small electric motor does the rotating. This and a number of other motors which operate the various parts of the apparatus is controlled by means of a bank of push buttons on the desk of the speaker. Throughout the hour this speaker, who understands the mechanics of the heavens, explains the phenomena he displays. Thus, as the motor runs, we see the stars rise in the east, culminate and set behind the "distant" western horizon. But the 24-hour astronomical day, which runs off so slowly in the actual heavens that we find it difficult to follow in easy sequence its deliberate events, may here be run off in only four minutes; indeed, if desired, in one minute.

Thus the motions and apparent motions of the heavenly bodies are accelerated and multiplied many fold by this universal mechanism or mechanical universe, and we are able to visualize them clearly, as a whole. It is comparable to those moving pictures, familiar to all, in which an invisible slow happening such as the gradual growth of a root or tendril, is depicted within so short a period that we gain a clear idea of it.

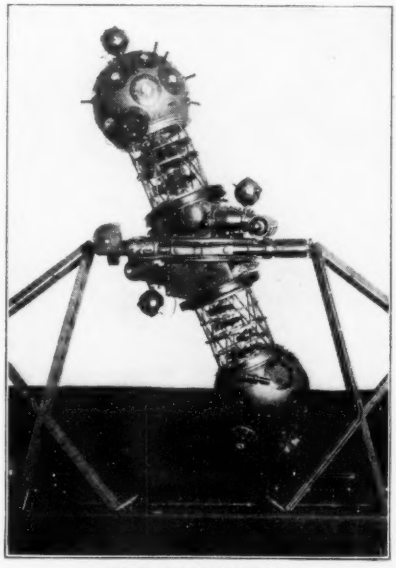
Thus far we have the heavens and they are in motion but, as in Genesis I, 15, our universe is not yet complete—we must add the planets. This brings in some interesting problems of machine design, for you cannot have your planets in motion at the same rate as the stars. Nor is this true of the sun and moon. Each pursues its separate course "through" the fixed stars. Again we have recourse to the photographs of the apparatus and to its section drawing. The planets are in the "handle" parts of the dumb bell. Each "planet" consists of a train of driving gears, especially designed, and now one gradually begins to realize why the apparatus costs so much: it is full of special design; while the lower cost due to mass production is impossible. In each planet there are two pins joined by a connecting rod. Only the earth-sun disk is perpendicular to the long axis. The others are placed at different angles. These correspond to the various angles the respective planets' orbits take with the plane of the ecliptic. This involves another bit of "fussy" design.

To see the outer planets in sensible motion through the stars when the whole heavens are speeded up many thousand times is to understand their motions almost at a glance. This gives



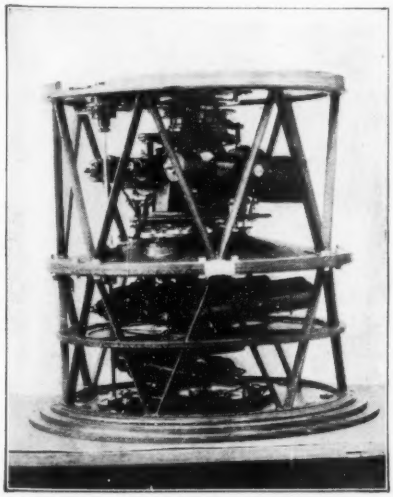
LONGITUDINAL SECTION OF PROJECTOR

1, polar axis; 2, axis of ecliptic; 3, axis for varying latitude; 4, 5, projectors for 5400 stars; 6, projectors for 18 clusters and nebulae; 7, 8, projectors for 32 constellation names (when desired); 9, 10, Milky Way; 11, sun, moon, Saturn; 12, Mercury, Venus, Mars, Jupiter; 13, 14, ecliptic, celestial equator, poles; 15, 16, meridian; 17, scale of years; 18, diurnal motion motors; 19, annual motion motors; 20, precession motors; 21, motor for 3; 22, contacts for leads to motors; 24, carriage (projector can be moved out of way for other entertainments)



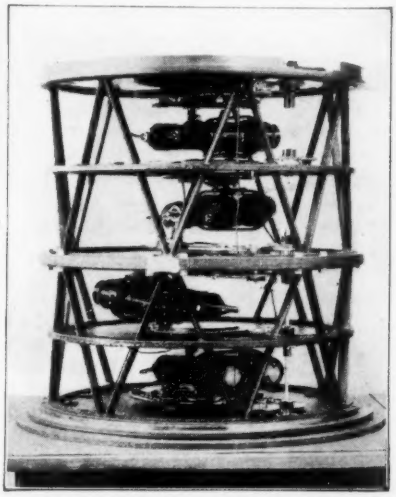
THE PROJECTOR

An intricate and beautiful piece of design. Weight 3500 pounds; 119 projectors



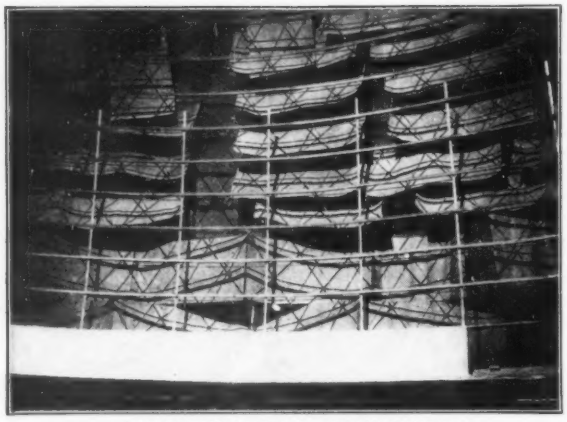
SOLAR SYSTEM PROJECTORS

The sun, its halo, zodiacal light, moon, Saturn—each has its specially geared projector, each requiring a special design



SOLAR SYSTEM PROJECTORS

These, from top to bottom, are for Mercury, Venus, Mars and Jupiter. Note the thin gears set at varying angles



A REMEDY FOR BAD ACOUSTICS

A light interior framework supports irregularly hung pieces of sheet iron. Light linen applied over this forms the spherical projection surface but transmits the sound through

in a few minutes an epitome of a whole year of astronomical events. If a day is made to last four minutes, then Mars is seen to revolve around the sun in 7.2 minutes actual duration; Jupiter creeps along at the rate of 47.2 minutes. Saturn, even then, is barely in sensible motion at the rate of one revolution in 2 hours 56 minutes. Uranus and Neptune are omitted entirely from the projector because they are never visible, anyway, to the naked eye. The inner planet Venus is lively, making the round of her orbit in only 148 seconds, while Mercury whirls round and round in only 58 seconds. If the whole process be quadrupled in speed by pressing another button Mercury now reminds one of a moth, flitting round and round a lamp in only 14 seconds; incidentally throwing light on the derivation of the word "mercurial." There is something ludicrous about the inner planets when thus seen revolving about the sun at a highly accelerated rate. Mercury is a gadfly and even Venus herself is mercurial and lively. The ponderous outer planets are "dignified old parties," not deigning to move with haste even when they are forced to accelerate a few thousand fold.

Thus it gives one a decidedly distinct picture of all the exasperatingly slow motions one sees in the heavens, this planetarium, and a better conception in ten minutes than one could acquire in a lifetime of patient outdoor observing and attempting to remember the continuity through months of elapsed time.

NOW the speaker who conducts the performance will put on some astronomic stunts. He has shown how the heavens look from Chicago or Philadelphia. He wishes to show how they would look from the equator; from Buenos Aires; from, let us say, Commander Byrd's base in Antarctica; and from the North Pole; or from any intervening point. To shift the point of view requires only to press a button, nothing more. A motor (at 21, in the drawing) will rotate the whole apparatus quickly about the horizontal axis which supports it. The axis 1 (in the drawing) must be made to point to the pole of the heavens—be parallel with the earth's axis—wherever we are. Therefore we shift our imaginary latitude or point of view on the earth simply by changing the angle of this axis with the earth's surface.

Now the aspect of the constellations is changed and those of us who are familiar with their outlines are temporarily confused. The stars are no longer in their familiar places. At the equator the Pole Star is on the theoretical horizon but actually is invisible. In Buenos Aires we find the sun and stars rising in the east and setting in the west as at home, yet traversing the northern instead of the southern arch of the heavens. At the poles we are able to see the midnight sun, and at the North Pole we see the Pole Star directly overhead.

We can shift our point of view, in the planetarium, not only in space but also in time. We can easily retrace our steps to the days of the later Cro-Magnon races, 14,000 years ago; or we may jump ahead to see how the skies will look to our descendants several thousand years hence. To accomplish this the little motor at 20 in the drawing, is set in motion. Four minutes of this carries us through 26,000 years, the period of that peculiar gyroscopic motion of the earth which brings about what the astronomer calls the precession of the equinoxes. The earth wobbles, or precesses, as it rotates; much as a top wobbles. Each wobble is in a circle 47 degrees in diameter and requires 26,000 years to complete. This means that the Pole Star is not a permanently fixed reference point. Just now, during our lifetime and during our "epoch," it happens to lie almost in line with the prolongation of the earth's axis. But Vega will be the pole star in 14,000 A. D., and Vega is a long distance from Polaris. At that time the Southern Cross, even now occasionally visible low on the horizon in southern Florida, will be visible from any point in the United States.

ANOTHER bizarre spectacle is eternal night and eternal day, a condition which does not exist in fact, except possibly on the planet Mercury. The rotation of the earth is slowed down until only a single rotation is made in a year. This has the effect of keeping the same face forever turned toward a merciless sun, and the opposite face toward the dark depths of space. With eternal day there would be no sunrise, no sunset. In the planetarium we now see the two inner planets Mercury and Venus revolving around and around the sun, always above the horizon, an impressive spectacle. Or, if we shift to eternal night, we shall see the stars no longer making their familiar rounds about the pole star but about the pole of the ecliptic.

With the planetarium we take the solar system to pieces and see how the pieces work. Superhuman feat! It is the best "movie" I have ever seen.

THE NEW PLANETARIUM FOR MOSCOW

The following communities have planetariums: Munich, Jena, Berlin, Dusseldorf, Barmen, Hamburg, Hannover, Leipzig, Nuremburg, Stuttgart, Mannheim, Dresden, Vienna, Rome

OUR POINT OF VIEW

Charles Francis Brush

DURING the night of June 15, there died in the city of Cleveland, a man with a keen scientific mind and indomitable will power who, at the age of 26, in 1875, developed a dynamo which holds its own even today after 50-odd years of improvement in electrical apparatus; who, in 1879, invented the arc light which won for him world-wide fame, great wealth, the Rumson Medal, and many decorations; and who, during his lifetime, perfected many remarkable inventions and worked out a number of elaborate scientific theories. That man was Charles Francis Brush, outstanding scientist, philanthropist, and humanitarian.

Born in Euclid Township, Cuyahoga County, Ohio, March 17, 1849, young Brush showed great precocity in science. At the age of 13, he constructed his own static machines, electro-magnets, and batteries—these at a time when the practical application of electricity was in its early experimental stage. He was graduated from the University of Michigan at the age of 20 and later achieved a doctor of philosophy degree at Western Reserve University. He received numerous honors from scientific and philosophic societies and from universities.

Few in American history can compare with Mr. Brush, and in many respects he had no peer, for rare is the man possessing the ability and ideals that were his. Active until his fatal illness at 80, he busied himself with scientific problems and humanitarian work. Of the latter, perhaps the best known is his establishing of the Foundation for the Betterment of the Human Race.

No words could exaggerate the worth of this great man, no panegyrics would be too costly in effort; and if this magazine ever establishes a Hall of Fame, one of the very first names to be inscribed there will be: Charles Francis Brush.

Now the Air Country Club

WHILE golf may continue for years to lure sportsmen and tired business men to country clubs, the rapidly increasing interest in aviation points to the inevitable divorce from this sport of many of the more adventurous souls who will, instead, take up flying. Foreseeing this, a group of aviation enthusiasts have organized what is known as Aviation Country Clubs, Inc. The first club to be completed under this plan was recently opened at Hicksville, Long Island, and already plans for over a hundred more are under weigh.

The club at Hicksville spent more than 300,000 dollars in building a club house, landscaping the grounds, and building a hangar and service station. Charles L. Lawrance, of Whirlwind engine fame, is president of the club, men prominent in aviation and in New York business compose its Board of Managers, and many sportsmen pilots—veterans and tyros—will make up its membership; while the lists of National Governors and national members read like a "Who's Who in Aviation."

Such a plan as this had to come. Too many people were becoming keenly alert to the sporting possibilities of aviation for present commercial fields to take care of them. And although to many people the country club connotes so much wealth that they feel their inability ever to belong, there is such a fine spirit of camaraderie among aviators that this idea should not hold in the case of the air country clubs. Sportsmen with a zest for flying should find the hangars of these new clubs open to them without undue formality or payment of unreasonable dues.

Every Ship a Lifeboat

AFTER six weeks of difficult negotiations, the delegates of 18 maritime nations, attending the Conference for Safety of Life at Sea in London, signed a new international sea safety code early in June. The agreement will now have to be ratified by the various nations concerned.

The wisest provision of the code, it seems to us, is that which makes compulsory the carrying of efficient wireless equipment by all vessels of over 1600 tons, except in specific cases such as passenger ships that do not go more than 20 miles from land between consecutive ports or cargo vessels that do not go more than 150 miles from land. All vessels must carry lifeboats; navigation rules are stricter; and internal construction of ships must be modified for greater safety, according to the new code. The United States will continue to operate the ice patrol. Lights and signals for vessels anchored or aground must be provided, and fog signals for 350-foot vessels, towed vessels, or those aground near a ship channel have been changed. Rules for procedure in case of disaster, for stability, for distribution and launching qualities of lifeboats, even for apparently unimportant details of construction, and many other items were included in the code.

The code has a scope much broader than any heretofore drawn up and represents a great forward step in the cause of safety at sea. It will not mean the complete defeat of the hazards of the sea but, with its ratification and the co-operation of the maritime nations, it should be the means of preventing another disaster such as befell the *Vestris*. The delegates to the Conference are to be congratulated on the completeness with which they accomplished their difficult task.

Clothes Make the Man—Hot!

THIS summer, women's clothes have been conspicuous by their absence. Décolleté street dresses have been very much in evidence, bare arms have "flourished" as never before, and sox and bare legs have become so common, in certain metropolitan sections at least, as to cause not even a traffic hold-up. As for the scantiness of other things, comment is unnecessary.

Children's clothing, too, has been of the simplest kind. The younger children especially have enjoyed the summer and remained cool in suits amounting to nothing more than trunks and a bib.

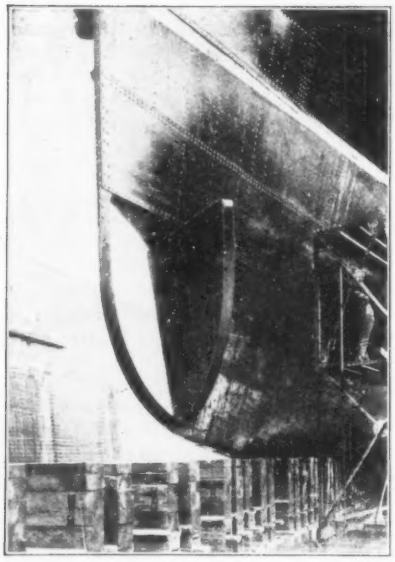
But how the men have sweltered! And how we've wished for simpler, cooler garb! Our women-folk say we must be conventional—we must dress as usual, even to a waistcoat, in the warmest weather—and the tailors say they won't let us throw off our excess poundage of clothing since it would ruin them. We've sworn we'd break away some day, damn convention and the tailors, and dress for comfort. Such outbursts, however, are mere bravado. We simply haven't the individual initiative, due most likely to our decreased efficiency which is due, in turn, to our eight or ten pounds of clothes; and, collectively, we seem unable to function.

Fortunately, there has recently been much more agitation for radical reforms in men's clothing than ever before. Will we forget it all with the coming of cooler weather this fall? We will not! There must be a concerted effort before we can overcome the apathy of old-fashioned dressers and the inertia of those invertebrates who would rather let someone else take the initiative. A lot of proselytizing is necessary, but we simply must have our comfort.

From the Scrap-Book of Science

EDISON'S FIRST LAMP FACTORY PRESENTED TO MR. FORD

Fifty years ago Thomas A. Edison invented the incandescent lamp in the factory shown below. On June 22, 1929, Mr. Edison presented this shack to Mr. Ford and it is to be dismantled, shipped, and re-erected at Dearborn as part of the Edison Institute founded by Ford. At left are Mr. Edison and Mr. Ford holding the original and a new lamp

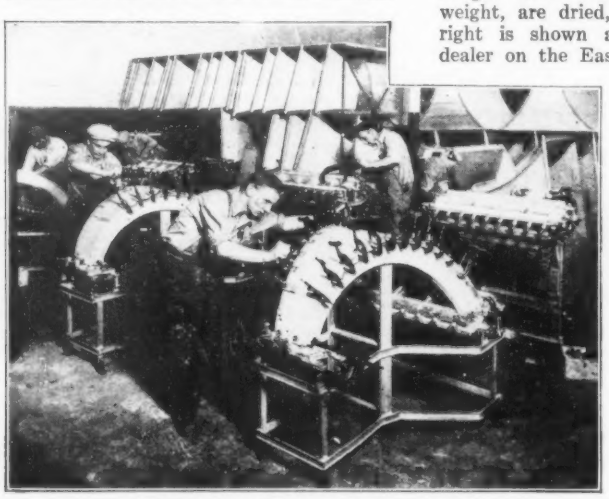


BOW RUDDER

To facilitate control of the vessel in narrow channels of the Pacific coast, the *Princess Norah*, latest acquisition of the British Coastal Steamships of the Canadian Pacific Railway, was equipped with a bow rudder, as shown in this photograph of the new ship

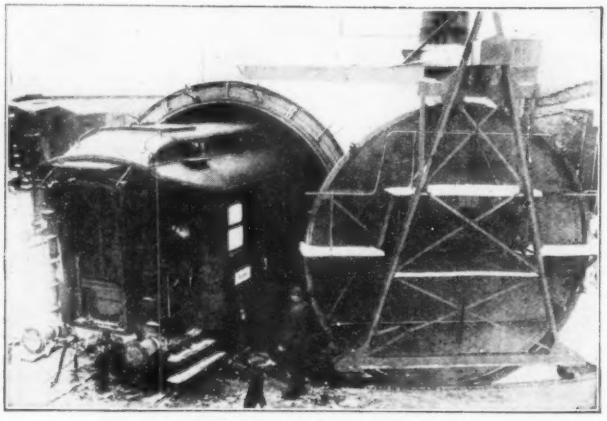
QUEER FOOD

Spaniards and Italians in the larger cities of the world eat with relish baby octopuses which come from the waters off Algiers and Spain. They are caught when under five pounds in weight, are dried, and shipped. At right is shown a Spanish octopus dealer on the East Side, New York



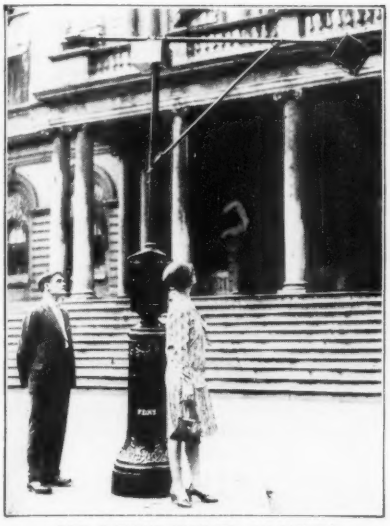
APPARATUS FOR "TALKIE" FILM

The horn is one of the most important factors in the new art of sound pictures. The photograph shows workmen gluing "orthophonic" horns for sound picture reproduction. The work requires highly developed craftsmanship as the eveness of the curve in the horn structure is of utmost importance for tonal quality. The scene above is from the Western Electric Company's plant, Chicago



EXIT BUGS AND GERMS

After each 35,000 miles of service, every car on the German National Railway is sent to a shop in Potsdam for complete inspection, disinfection, and overhauling. The car is rolled into a cylindrical tank which is then hermetically sealed and filled with disinfectant. The chemical does its work, and the car is then removed for overhauling. The photograph shows a car being placed in the tank

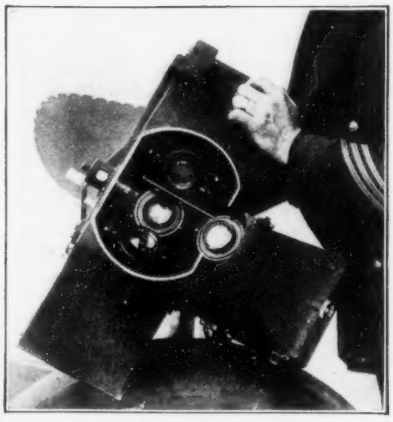


NO MORE FALSE ALARMS

When fire alarm boxes are equipped with this device, jokers and false alarm "bugs" will have the joke turned on them. The alarm will be turned in, but the device will also photograph the person who turns it in. If the alarm is false, the photograph will serve as a clue to the joker

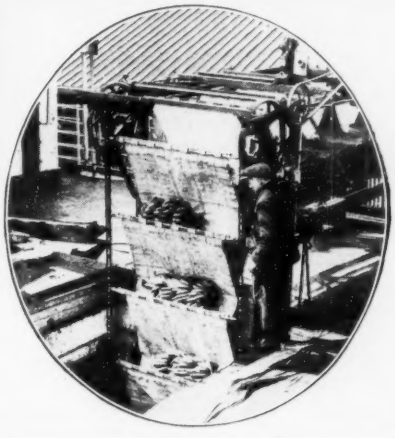
ALASKA IS MAPPED

Recently the United States Navy's second aerial mapping expedition to Alaska left San Diego, California, to finish the work started four years ago. The new expedition will map from the air Chicakof and Baranof Islands, probably basing at Sitka and working north from Christian Sound on Baranof to Icy Strait on the northern tip of Chicakof. Above is shown one of the navy planes over Mendenhall Glacier, and at the right is the camera to be used, showing four lenses



SOUND-PROOF CAGE

In making sound pictures, it is important that no sound from the camera shall reach the "mike." Such pictures are "shot" from within a cage through a glass window as shown in this view taken through cage door

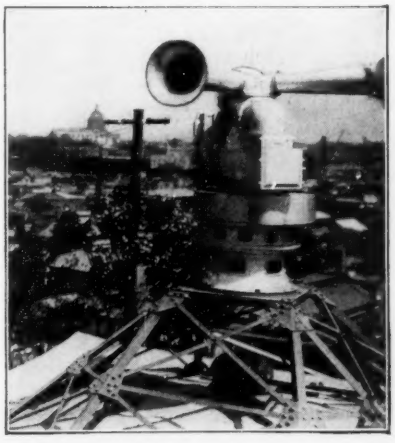


YES, NO BROKEN BANANAS

Much faster and far more efficient than the hand method of unloading bananas from ships, this electric elevator was recently placed in operation on the docks in London, England. It consists of canvas swung between the chains of an endless conveyor

SMELLER BY PROFESSION

This is no joke nor is the man paying an election bet by attempting to emulate the elephant; his is one of the world's strangest professions: that of gas-smeller. A number of these experts go about Berlin, stick long tubes in the ground, and sniff. When they detect the odor of escaping gas, they call the gas company's repairmen



SCREECHING THE TIME

In Tokio, the hours of the day used to be signaled by the firing of a cannon at a nearby army post. The practice has now been discontinued by imperial order and this large fire siren signals the time from the top of a building

Licorice the Versatile

This Age-old Sweetmeat, Medicine, and Sacred Herb Links the Modern World With Ancient Peoples and Religion

THE history of licorice is as old as the history of medicine itself. It is replete with folklore and tales of religious and occult uses. As that eminent pharmacologist and author of "Etidorpha" and "Stringtown on the Pike," Dr. John Uri Lloyd, has so aptly said, "Licorice has always been used to such a great extent that it is very generally assumed that everybody knows all about it, and hence very little has been written concerning it." It will probably surprise many of our readers to know that it has other uses than in medicine and confectionery.

In childhood days most of us have chewed licorice root. The slender sweet sticks were sold for a penny a piece. Most of us have also bought attractive licorice candy, such as "shoe laces," "nigger babies," and in other fascinating forms. It is a curious fact that licorice candy need not be black at all, for while the normal color of pure licorice is a brownish-black, that of some licorice candy is like mocha, from the blending of a small proportion of the dark brown licorice with white sugar. Later on in life doctors have prescribed licorice to ease our coughs and sore throats and as other aids to health. After we are grown up many of us have met licorice as a flavoring material in tobacco. It was probably not apparent in pipe and cigarette tobaccos, but would be recognized in chewing tobacco, of which it is an important ingredient.

THERE is real romance connected with licorice, which reaches back into the earliest recorded history and beyond. It was known and grown in that region of Mesopotamia which is regarded as the cradle of civilization. The famous Egyptian alchemists and learned Greek physicians knew its worth. During the dark ages thousands of tons were consumed in all parts of Europe. The root was usually gathered in the fields of Arabia. The ruins of the alleged Tower of Babel arise from the center of the licorice belt, in a section which produces large quantities of the root. Theophrastus, who is called the "Father of Botany," and who was the pupil and friend of Aristotle, wrote three centuries before Christ — "Scythian root (licorice) is also sweet; some, in fact, call it simply 'sweet root.' It is useful against asthma or dry cough and in general troubles of the chest, and is also administered in honey for wounds. It has the property of quenching thirst, if one holds it in the mouth; wherefore they say that the Scythians, with this and mare's-milk-cheese, can go for eleven or twelve days without drinking."

Few of us have thought of licorice being used in warfare, and yet, aside from its use in treating wounds, we can see where it was a real advantage to the armies of these ferocious, warlike peoples in aiding them to make long forced marches without water.

Archeologists have discovered in the neighborhood of Ctesiphon on the river Tigris, near Bagdad, some remarkable tablets. As early as seven centuries before Christ they describe the use of licorice by physicians in treating their royal masters. The Indian Prophet Brahma recommended it to his people as a general tonic, beautifying agent, and elixir of life. The Chinese also made a regular practice of eating licorice. In fact, they still use it in large quantities thinking it keeps their bodies supple and increases their endurance and enables them to ward off old age—a large order! Down through the Middle Ages the use of licorice increased steadily, and during the Renaissance it became very popular as "sweet medicine."

During the reign of Queen Elizabeth, licorice root was grown in England in the neighborhood of the proud historic Pontefract Castle. A quaint English couplet of the thirteenth century indicates that licorice had become almost synonymous with sweetness:

"His love al so sweete, y-wis
So ever as milk or licorise."

Chaucer himself wrote:

"But first he cheweth greyn and licorys
To smellen sweete."

AS recently as 1900 a well known English physician, Dr. George S. Keith, wrote of the medical aspect of licorice as a curative agent: "Licorice has some most useful properties. For relieving the symptoms caused by acrid matters in the stomach, I know nothing to equal it, and I have used it for this purpose for at least 40 years. It certainly relieves, often in a very remarkable way, the innumerable pains and discomforts, mental and bodily, which arise from irritation of the gastric nerves, as local pain of stomach or bowels, headache, sleeplessness, lowness of spirit, or irritability and general misery. I have known relief from licorice in a very large number of cases both of dyspepsia and sleeplessness."

About one hundred years ago there penetrated into the ancient lands of the Near East an adventurous pioneer of industry bent upon the commercial utilization of licorice root. He took with him those servants of industry—the engineer and the chemist—a very wonderful thing for the time. The chemist found in licorice a wonderful new substance about 50 times as sweet as sugar—a substance found no where else in nature. This material was given the impressive name of "Glycyrrhizin" (which means no more than "sweet root"), and it is to this top-heavily named substance that licorice is indebted for its value as a flavoring and sweetening agent. In time the wholesomeness of licorice confectionery became recognized, especially in Europe where a large variety of licorice candy finds a wide and ever increasing sale.

As time went by the business of this pioneer increased so that it was necessary to have a fleet of steamers to transport the licorice root from Spain, Italy, Greece, Asia Minor, Russia, Persia, and China to the United States where the roots from the various

All photos courtesy MacAndrews and Forbes Company

UNLOADING LICORICE ROOT IN THE EAST

From hundreds of points the licorice root is brought to the sea coast by means of every imaginable kind of conveyance

sources were skilfully blended, just as is done with fine coffees and teas, and the extract, known as "paste," was supplied to the tobacco, pharmaceutical, and confectionery trades. We will describe some of the rarer but none the less useful qualities of licorice a little farther on.

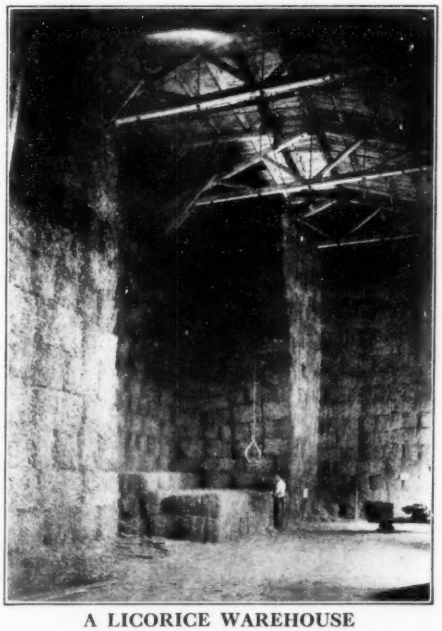
Large quantities of licorice are gathered every year, the total sometimes exceeding one hundred million pounds. If we could visit southern Europe and the Near East during the licorice harvest, we would see many strange sights. Thousands of peasants from Madrid to Bagdad, and from the banks of the Volga to the banks of the Nile, would be seen digging the root and carrying it in bundles on their heads and backs, or transporting it on the backs of donkeys and bullocks, or in carts, or on the backs of the patient camel. Spain, Italy, and Greece furnish a goodly share of the supply of the licorice root. The Jordan Valley, the Holy Land, the birth place of Christianity, and the fertile valley of the Tigris, all contribute their quota. The picturesque peasants who gather the root are a motley crew of Chinese, Jews, Arabs, Armenians, Turks, Russians, and Tartars, and the primitive picks which were used probably date back to the time of Abraham.

THE roots are carried to a baling station where they are inspected, weighed, and paid for. The roots are piled in huge stacks for curing, which occupies the entire winter, before the roots are dry enough for baling. The stacks of roots are protected during the rainy season to prevent mildew. When thoroughly dry the roots are pressed by hydraulic presses into bales weighing about 300 pounds and secured by wire or strap iron.

The transportation of these bales to seaports offers a big problem which has been solved by the natives in many ways. At various stations in the interior of Syria, Armenians and Bedouins are hired to transport the bales. The heads of the stations frequently advance considerable sums of money to buy camels and never seem to have their confidence misplaced. Should the collecting station be located on a river the licorice is transported in crude crafts, barges, and sailboats. Having been brought along side the steamer, the bales are hoisted on board and transported to the United States where they are piled in huge warehouses until the raw material is needed.

AN IMPORTANT LINK IN TRANSPORTATION

Much of the licorice root of commerce is brought down by camels to navigable rivers and the sea coast



A LICORICE WAREHOUSE

One of twelve huge licorice warehouses at Camden, New Jersey, safeguarding thousands of bales of dried licorice root

The process of manufacture is as follows: The roots, after going through what is known as a "bale breaker," are passed through a "shredding" machine where the tough fibers are reduced to a coarse mass. Part of this root mass is ground to a fine powder which is then sifted through a fine mesh and ground like flour. This powdered licorice root is of great use in pharmacy where it is used as an excipient and as a dusting powder. The remainder of the shredded root is carried by moving belts to the batteries of extractors where the active principle of the licorice is extracted, the process being chemically controlled; that is to say, samples are taken at regular intervals and tested. When the extraction is completed the solution is treated in various ways according to the uses to which the final product is to be put.

The solution is then "settled" in tanks and pumped to vacuum evaporators where the water is driven off while the solution is under extremely low pressure. In the ordinary method the solution was evaporated in open kettles, but oxidation due to exposure to the air is apt to take place. Care is taken to prevent "foaming" of the solution. The solution has now become very much concentrated and goes to drum driers, or what are known as "finishers." In the drum driers the solution comes in contact with an internally heated metallic cylinder. The solution which adheres to the drum is evaporated and carried to the scrapers during a partial revolution, and the material is scraped off and falls on to a conveyor.

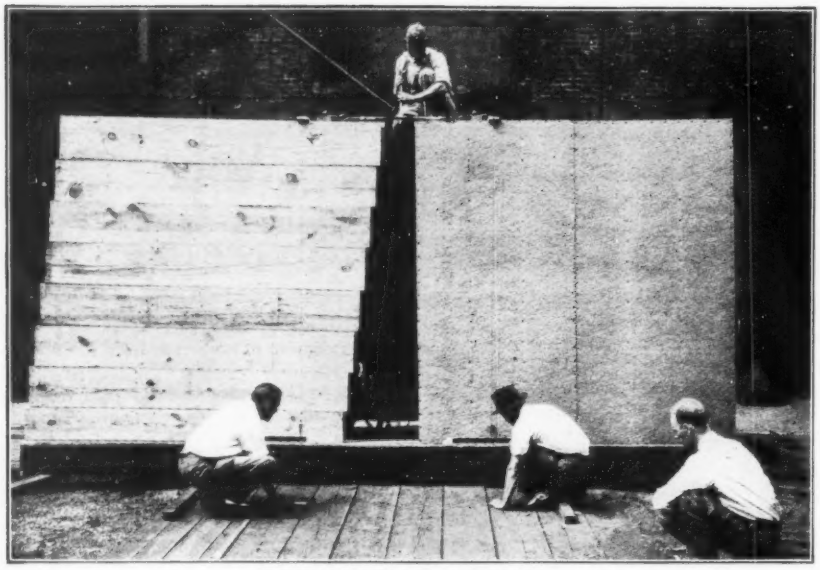
THE dry extract is then powdered and screened and is sold in commerce under the name of "powdered licorice extract." The licorice "syrup" as well as the licorice "paste" are the forms which interest the confectioner. The "paste" is obtained by treatment of the solution in the "finishers" where it is steam heated in copper evaporating kettles fitted with internal revolving scrapers which keep the thick paste from adhering to the kettle. The paste is drawn from the finishers and is weighed into paper lined wooden cases or cartons. It gradually hardens into a dark brown semi-plastic mass which is easily fractured by a smart blow.

In the past, the use of real licorice as a flavor in confections has been limited by two factors: first, the difficulty and cost of handling the licorice mass and second, the continual association of the anise flavor and the black color with "licorice" candies. The first of these has been eliminated by the introduction of soluble confectioner's licorice. The removal of the second should follow, for such a tradition is a handicap to the confectionary industry. The National Confectioners' Association is educating the people to realize that candy is not only a food but a health food. The health advantages of licorice are apparent.

A curious and minor use for licorice is to make a solution which is found to

A BULKY LOAD

This Tartar porter in South Russia is carrying licorice root to the baling press



THE END OF THE ROOT

All the goodness having been extracted from the root, the fiber which remains is made into a useful board which has great strength. Here we have a distortion test of "Maftex"

be excellent in etching steel sections in the preparation of photo-micrographs.

We now have the licorice in the form for pharmaceutical use and for the confectionery and tobacco trade, but abroad they use licorice in other ways. Throughout southern Europe non-alcoholic beverages made from water infusions of either licorice root or licorice paste have been very popular for generations. The value of licorice as a tonic and "blood purifier" has long been recognized, and large amounts of licorice beverages are drunk by the people during the spring and summer months. In most of the factories of France, and especially in the iron and steel mills, it is given to workers for drinking purposes instead of plain water, for it has been found that they are thus better enabled to stand the intense heat.

In Egypt hundreds of tons of licorice root are still used each year in making a drink known as "*mai sus*" (licorice water) which is an infusion of the root in cold water. It is a favorite drink among all classes at social gatherings and weddings, where handfuls of the milled root are thrown into large earthenware jars of drinking water. In Turkey, the well-known vendor of licorice water and sherbets with a brass urn on his back, is a noticeable and picturesque figure.

IN business, the modern dragon of expense is called "waste." What should be done with the root from which the active principle has been extracted? We all know the old story of the complete utilization of the pig, but here even the squeal has been commercialized, for a remarkable property of licorice was found to be that it possessed the property of foaming strongly. Brewers, when brewing was good, were in the habit of putting licorice in beer for giving it a "head."

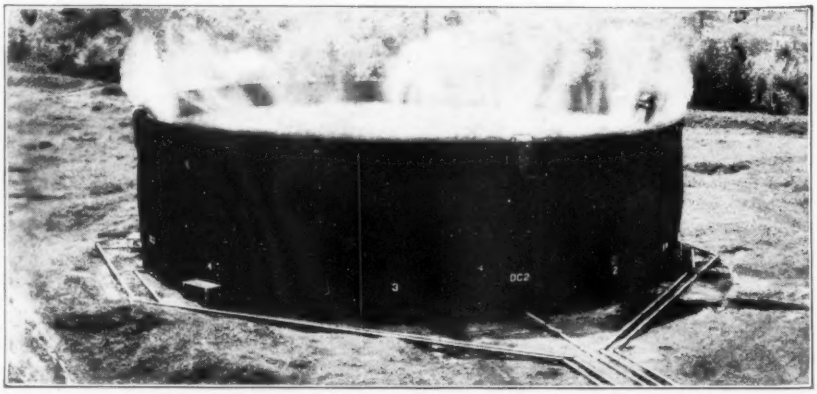
A stroke of genius applied this foaming property to the development of a revolutionary method of extinguishing fires. This method is based on the simple principle that fire immediately ceases to burn when the air supply is cut off by a layer of oxygen-free foam. First of all the licorice root is boiled with water to make the required extract for pharmaceutical and tobacco manufacture and the licorice syrup for the confectionery trade, as we have seen. Then the so called "spent" root is given a second extraction which yields a liquid of extraordinary foaming power. The Foamite system of fire extinguishing has resulted in great property savings.

It would really seem as though the poor root might now end its days in peace, but not so. The ultra-efficient manufacturer said, "Find me some use for the tough fiber of this spent root which we are now burning under the boilers simply to get rid of it." Laboratories were consulted and engineers made experiments, and in a short time a large paper mill was engaged in turning what was left of the licorice fiber into valuable commodities, such as wall board and box board.

It is a far cry from the plains of Damascus to the cardboard box in which a specialty shop may deliver milady's gown. Other fiber boards were developed and proved in many cases superior to those hitherto available. A notable example is the manufacture of "Jacquard cards," which are used in the weaving of tapestry and other figured materials. Holes punched in the cards control the woven design. Therefore, the cards must possess great rigidity and strength. Jacquard cards made from licorice fiber have won recognition as the best for this particular application.

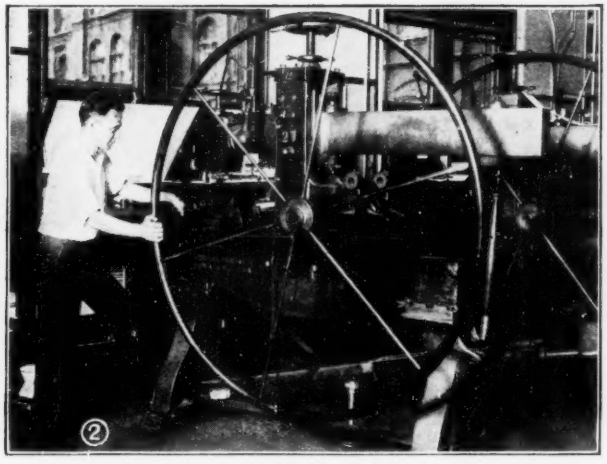
Still the engineer, the physicist, and the chemist were patiently searching and testing. It was found that the licorice fiber had other extraordinary properties besides strength. It proved to be a remarkable insulator. Heat and sound were unable to get through it. Thus the way was opened for another addition to the long list of licorice products—an insulating board which has enjoyed immediate acceptance as a phenomenal new structural material for the architect and builder, for factory construction, and for the home.

IMAGINE a tough fiber-board 8 feet long, 4 feet wide, and about ½ inch thick, superior to lumber for sheathing; a board with an ideal surface for receiving plaster; a board which prevents the passage of heat, cold and noise more effectively than a six-inch wall of brick, stone, or concrete; a board which gives the American citizen a more comfortable home for less money. The last vestige of the root has been utilized. The story of licorice in the service of mankind is ended.



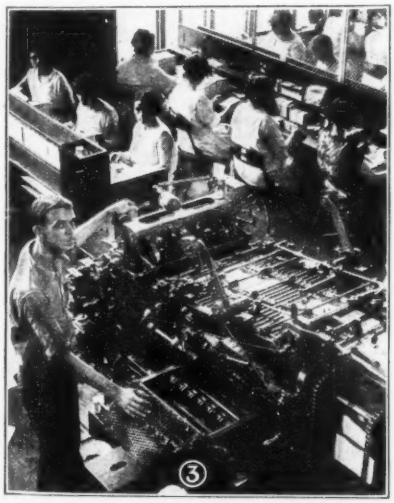
A LICORICE DERIVATIVE GETS TO WORK

Here is a product of the "spent" root. The second extraction gives a liquid of extraordinary foaming power. This is the basis of the "Foamite-Firefoam" method of extinguishing fires

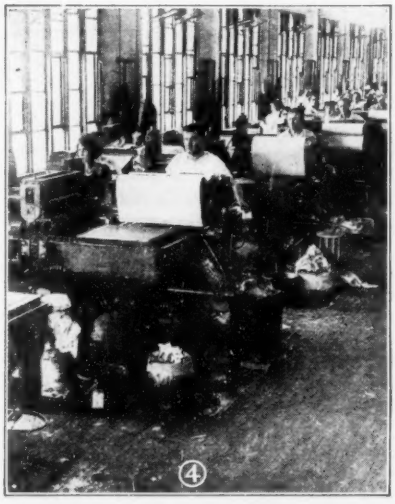


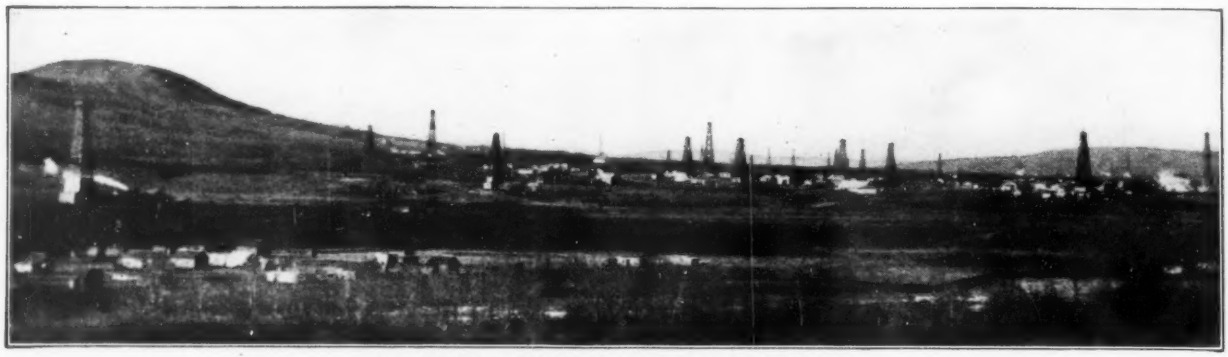
Uncle Sam Gives Us New Money

THE new currency which was issued in July by the United States Government certainly has many things in its favor. The new bills are smaller, and are therefore easier to fold and handle. They are also "sized" with a new preparation which protects them from grease and dust better than the old bills. The paper is improved both in strength and folding quality. The portraits on each note indicate the denomination. Washington appears on the one dollar bill; Jefferson on the two; Lincoln on the five; Hamilton on the ten; et cetera, until we reach the $10,000 bill adorned by a picture of Salmon P. Chase. The government will save large sums by the new money. It is hoped that the stepchild, the two dollar bill, may be restored to respectable billdom with its aggressive numeral.



THE production of the new money follows the same process as the old. The design having been decided upon, parts of it are assigned to specialized engravers who each engrave a part (1) on a small piece of annealed steel. After being inspected and passed, it is hardened. A reversed duplicate is made by rolling a soft steel cylinder upon it in the transfer press, (2). This gives a relief steel die which is hardened and in turn serves to impress an intaglio or recessed design, on a soft steel plate which is hardened for use. The steel-plate presses are of special design (3) and the paper is wetted before use. The printed bills are then sized and dried, but they do not become "money" until they are numbered (4) and the treasury seal affixed. The inspection (5) is rigid and then the bills are wrapped in packages (6) and they are ready for their journey to the ultimate user. The old money will soon be displaced.





THE TURNER VALLEY OIL FIELD IN CANADA

One of the most important developments in the oil industry has taken place during the past year in the Turner Valley, which is now producing oil at the rate of more than 1,000,000 barrels a year, and billions of cubic feet of gas containing high-grade naphtha

Why Does An Oil Gusher Gush?

An Understanding of the Importance of Natural Gas Replaces Misconceptions About "Oil Pools" and "Rock Pressure"

By ARTHUR P. WOOLLACOTT, F.R.G.S.

FOR the past two hundred years the United States has been riding the top-most crest of a wave of prosperity, which has made her the envy of the world. A virgin country with apparently inexhaustible resources when the Pilgrim Fathers landed, her swarming millions have since used up a considerable proportion of those reserves, piling up immense fortunes in the process.

The matter-of-fact economist now and then reminds the exploiters that you cannot eat your cake and have it too, but the significance of his language is not easily understood, and when understood is very seldom heeded. When the economist says that certain resources like minerals and oil are exhaustible and when once used are gone forever, most people will agree with him. They have agreed with him to the extent of believing that reforestation has become a necessity if we want any more timber. But when the "Go Slow!" sign is put up in the oil industry there is a tendency even among oil men to smile knowingly, and increase production, for if our oil is to become exhausted by 1950 as the United States Geological Survey asserts it will, why should oil men, who may be dead before that day arrives, worry in the meantime? You can't persuade the cheerful attendant at the filling station that he may eventually lose his job because there will be no more "gas" to sell; it is unthinkable.

However, no less a person than former Secretary of the Interior Hubert Work, having in mind the prediction of the United States Geological Survey, sent premonitory tremors of economic terror into the hearts of a few when he pictured what would be the effect of the exhaustion of our petroleum supply.

It would be a catastrophe second only to the World War; without oil a modern war could not be waged; millions of automobiles would halt; marine transportation would be radically affected, aviation would be paralyzed, and numerous other inconveniences would follow, not the least of which would be the necessity on the part of the United States to buy oil elsewhere to the tune of more than a billion dollars a year.

SO today we have methods of conservation in operation which are of greatest importance to the public, since their tendency is to prolong the life of oil production, and thus make it possible to continue the national joy-ride until science comes to the rescue with some other cheap source of power when the fields are at last exhausted, as they certainly will be sooner or later.

One's first thought on looking at a "gasser" spouting its millions of cubic feet of gas into the air every day, or a "gusher" throwing up its thousands of barrels of oil, is, "How long will it last?" Wells have been known to emit a steady stream of gas for twenty years or more, while producing oil wells have been flowing steadily for half a century. On the other hand, we have wells that have come in before lunch with a force and volume sufficient to justify the owners in thinking that they were at last in the millionaire class, only to sputter and die down to a feeble oozing from the casing-head before night.

Why the difference? Once upon a time it was thought that oil was forced up from below by what was called "rock pressure," the assumption in the mind of the reader being that the enormous weight of the rock above the oil "pool" forced up the gas or oil in that great spurt known as a "gasser" or a "gusher" as the case might be. But if by "pool" is meant a lake of oil, and by "rock-pressure" the weight above, then the terms are misleading for oil does not exist in pools, nor is it forced up to the surface by the weight of the earth's crust.

Both gas and oil are found in the permeable sandstones and limestones only when these strata are in between layers of harder and more impermeable rocks, like shales, which prevent the upward and downward escape of these products. But both gas and oil are forced through a stratum by the flushing action of water and by gas expansion, often many hundreds of miles under the basement of the plains, unless caught and held in a favorable "structure," that is to say, in the arch of a roll or fold in the strata.

Gas is regarded as a distillation product of oil, and may be either "wet" or "dry." The former produces high-grade naphtha in varying amounts according to its "wetness." The Canadian well Okalta No. 1 in the Turner Valley field in Alberta recently blew in with a production of 32,000,000 cubic feet of exceedingly wet gas a day, which upon extraction yields 1000 barrels of 72° Baumé naphtha a day worth about $4.26½ a barrel. Other gas wells produce a dry product useful for industrial purposes, but containing no gasoline in sufficient quantity to warrant extraction.

One can understand a wet or dry gas coming to the surface because it is of the nature of gases to expand and escape, but what brings up the heavier oils?

It is now generally recognized that the presence of gas dissolved in the oil is the chief factor in causing oil to move into a well and out of it again. In other words the so-called "rock-pressure" is nothing else than gas-pressure. If there is no gas present in the oil, there is no pressure, and no flow into the well. From this it will be apparent that there is necessarily a "gas-oil ratio," that is to say, the number of cubic feet of gas required to move a barrel of oil out of a well. Gas-oil ratios vary from 3000 cubic feet per barrel of oil, to 20,000 cubic feet in wells that are not controlled by "back-pressuring." The difference in expenditure of gas-energy, it will be observed, is very great. Some wells require as much as seven times more force to lift a barrel of oil to the surface than others.

It will be realized also that there exists for every well at any time in its history an economical gas-oil ratio, which will give the greatest oil flow with the least expenditure of gas. This ratio must be found by experimenting with back-pressuring, a term that is best illustrated by the familiar trick of placing a finger over the nozzle of a hose. The more you stop up the opening the greater the back-pressure. In the case of an oil well this is done by placing a metal pressure "bean," which may be from one to two or three inches in diameter, in the orifice of the escape pipe. This method enables a smaller amount of gas to lift up a larger amount of oil and so tends towards economy.

The entire contents of a well, when the oil or gas horizon is tapped by a drill hole, are forced out as rapidly as the size of the bore-hole will allow. This is true so far as the gas is concerned, and true of the oil also to the extent of its associated gas. The escaping gas, however, does not carry along with it all the oil. In fact only a small proportion of the oil in any field is ever recovered. Once the gas in that field is exhausted, no further oil can be obtained except by the slow process of pumping, and if there is not sufficient gas left in the strata to drive the remaining oil into the well, even pumping will not bring up what has not reached the well.

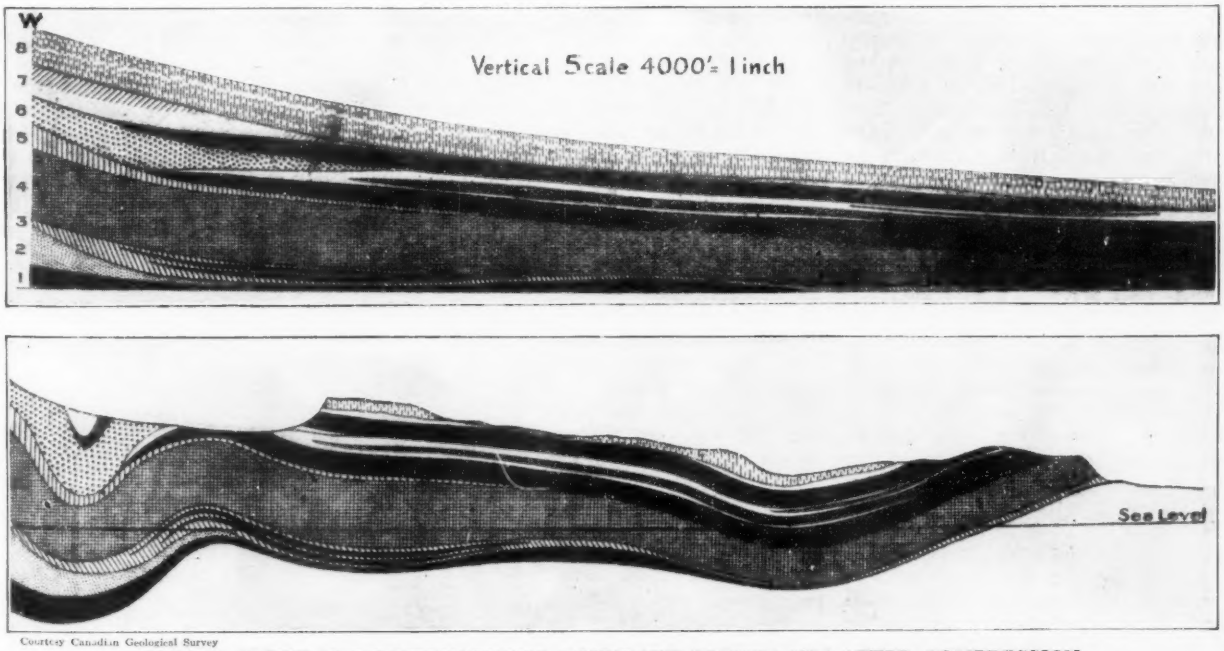
FROM all of which it is clear that gas conservation in an oil-field is the primary concern of the prudent operator. The Canadian fields, profiting by the lesson of the terrific waste in other fields, are conserving their gas, forcing the surplus under 750 pounds pressure back into the exhausted Bow Island sands. This huge underground natural gasometer, south of Medicine Hat, will ultimately hold twenty billion cubic feet of gas in storage for any purpose for which it may be required.

Although the southern California operators are now swinging into a high rate of production that seems destined to react unfavorably on the industry before the end of the year, many operators in the Long Beach and Santa Fe fields have indicated their willingness to help the state conserve its natural gas. During a recent month the gas held in the ground amounted to 146,782,000 cubic feet a day. Of the 918,199,000 cubic feet of gas produced in these fields daily, there were 350,346,000 cubic feet used in the field; 310,971,000 sold to consumers, 217,300,000 lost, principally through new wells "blowing off," and 11,433,000 cubic feet injected back into the ground for "back pressuring."

It is well known among oil men that with ordinary flowing and pumping methods, a comparatively small part of the original oil content of the sands is ever brought up, while with efficient control of gas production and pressure, together with proper well spacing, it is estimated that the recoverable percentage will be doubled. Fields already depleted of gas may be rejuvenated by gas injection on a large scale.

Gas injection under pressure into an exhausted field is now practised for three distinct purposes—to raise and maintain a pressure that will result in further recovery of oil; to store surplus gas for future use; and to circulate dry gas as an absorbent agent through unrecoverable oils in order to extract from them their gasoline content.

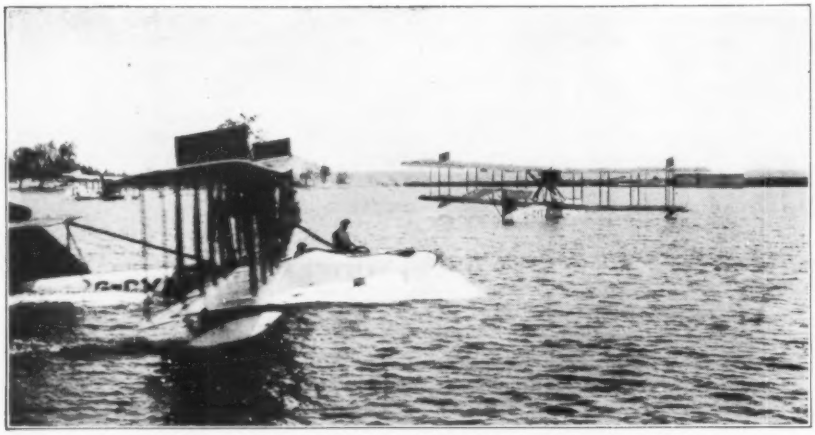
Worth-while results of gas conservation and increased oil recovery cannot be obtained without co-operation on the part of the producers, especially when the owners are numerous and the wells close-spaced as in the "town-lot" sections around Los Angeles. This is particularly true in the present situation where the overproduction of both gas and oil exists with consequently low prices for oil and natural gasoline.



Courtesy Canadian Geological Survey

STRATA ALONG THE INTERNATIONAL BOUNDARY BEFORE AND AFTER COMPRESSION

Top: Ideal section, showing deposition of sediment and oil-bearing sands, 2, 3, and 5. Arches, domes, and anticlines shown below were caused by lateral compression when the Rocky Mountains were elevated. Oil and gas permeating the softer strata may collect in a fold



FLYING BOATS USED IN CANADIAN AERIAL SURVEYS

Equipped with powerful flying boats of the type shown here, Canadian cartographers are making accurate maps and forestry sketches of the little-known regions of the far north

Charting Canada's Wilderness From the Air

Rich Mineral Areas Amid Lakes and Forests of Northern Canada Mapped Accurately for the First Time

By JAMES MONTAGNES

FLYING high above the forests and lakes of the great Canadian northland, photographers are now mapping thousands of square miles of wilderness. Districts which have been mapped only by surveyors, who went into the immense country by boat and so only followed the waterways, are now being photographed from the air. Detail maps now are available, from the Topographic Survey of Canada, for a great part of the north, from Wood Buffalo Park, at the boundary of the province of Alberta and the northwest Territories, marked by the 60th parallel of latitude, down through northern Alberta, Saskatchewan, Manitoba, and Ontario to the St. Lawrence river. This region has come into prominence the past few years because of well-known mineral discoveries, and the subsequent development of water power resources.

Immediately after the World War, Canadian aviation was organized to meet the needs of a country which was but partly explored. Aerial mapping and sketching were two of the items included in the program. By the end of 1927, 162,000 aerial photographs had been filed by the Topographical Survey of Canada, and during 1928 aerial photography by the Royal Air Force amounted to 947 rolls of exposed film.

When an area has to be photographed for map-making purposes, the usual type of photographs taken are known as obliques, which are taken with a view of the entire territory to the horizon. These photos are made with a hand-operated camera mounted in the front of the flying boat used. For each picture taken, the exact angle of the camera must be noted. In order that an accurate picture of the country be obtained, three photographs are taken from approximately the same position in the air, one straight ahead, and one to each side. Since the ship is moving along at 80 to 100 miles an hour, there is a slight change in the territory taken in by each of the photographs. However, since the pictures are taken to overlap each other for at least 50 percent of the view, this deviation means very little, and when the three are put together, an accurate photograph is obtained of the country at that particular spot.

Vertical photography is employed in districts where the detailed map work requires views looking straight down. They are taken by an automatic camera set in the hull of the flying boat. Three pictures are taken of each location photographed, at 10-second intervals, with an interval of 20 seconds between each group of three pictures. Thus the overlapping is again very great, making for extreme accuracy when the photographs are used in a map.

Utilization of vertical aerial photographs for mapping purposes is very often greatly facilitated by the absence of marked relief and by the presence of the original cadastral surveys, by means of which the area had been previously subdivided into mile and half-mile squares. The fences subsequently built by the quarter-section owners around their holdings, and the traveled roads adjoining these lines, furnish a checkerboard control when such characteristics are visible from the air. In many cases the distorting effects of tilt and "slight relief" of the photograph become of negligible magnitude, in so far as they affect the reduced scale of the issued map showing these half-mile squares.

A FLIGHT crew sent into any district to take photographs will have maps of the region, marked at two-mile intervals. A ground expedition will have gone in and marked similarly the territory to be covered at two-mile intervals with certain landmarks visible from the air. These the pilot and surveyor will correlate with their maps. A line of such markings at each side of the region to be photographed allows the pilot to bring his plane to one such mark, and by compass direction fly along that line to the mark at the other end. Meanwhile, as the pilot flies from one mark to the next, the photographer is taking pictures. Oblique photographs made at a height of 5000 feet take in a two-mile region.

The same procedure is followed for each line shown on the map that must be photographed. The same route is traversed again from a height of 10,000 feet if vertical photographs of all or part of the region are required.

PUTTING IN THE THIRD DIMENSION

By using the stereoscope, as shown in this picture, the map-makers are enabled to calculate the elevation

Both systems, as mentioned, have an overlap in each photograph of at least 50 percent. In vertical photography this is essential so that on each photograph its principal point, the center, can be marked; by means of the detail on it, the location of the principal points of the two adjoining photographs can be found. Thus a common direction is established between successive photos of a strip. Using clearly identifiable points selected on each photograph, one lying near each side limit of the photo opposite the principal point and appearing in the overlap common to three photographs, a skeleton triangulation is projected to the approximate scale of the photos through each strip, and intersections are made on control points at each end of the strip.

THE intersected terminal points will serve to determine the scale of the skeleton plot, and to fix the map position of the principal points of each photograph of the strip. The detail required to be shown on the finished map is next traced on the skeleton plot from the overlapping photograph, by adjusting the apparent positions of each point traced from two photographs so as to fulfil the radial assumption. The various strips are then reduced by pantograph to the map compilation or projection sheet, upon which previously have been plotted the terminal-intersected control points. Thereafter the projection sheet is rephotographed and a blue print obtained as a base for the draftsman's finished copy.

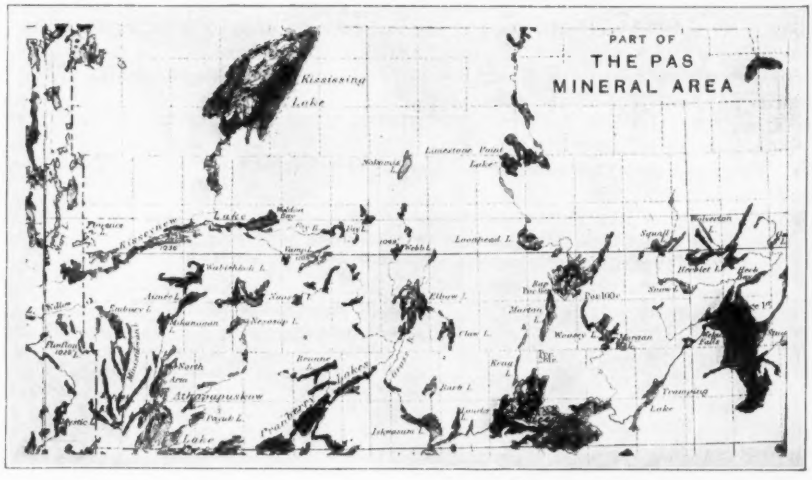
In oblique photography a grid gradually receding to the horizon is applied to each picture, in order to obtain the relative tilts and positions of the principal points of adjoining photographs. Once the directional line has been established by this method the procedure for mapping becomes similar to that for the vertical photographs.

The value of aerial photographs outside of their use in mapping is apparent in the planning of power sites. It has been established that the feasibility of a water power or storage development can generally be ascertained by a stereoscopic study of aerial photographs, often without any field work. In cases where some field work is necessary, a preliminary study of the photographs will reduce it to a minimum, and will enable the engineer to report definitely after only a few careful measurements at critical points. In Canada, where hydro-electrical development is so often in heavily-wooded country, difficult of access, this new application of aerial photography promises to be immeasurably useful to engineers. Aerial photographs, incidentally, have also been useful in the location of transmission lines and railway right-of-way, with results that could not be obtained by any other means in the same time and with the same expenditure.

Mapping a district from the air is faster, as well as more accurate, than by the old method. Although there are but an average of 26 days a year clear enough for aerial photography, a plane operated eight hours a day with an average speed of 100 miles an hour can photograph 1600 square miles a day. The Fraser River Canyon in British Columbia was mapped from the air in one season. It had taken five years to map it on foot.

As an example of how incomplete a map may be when made by a surveyor traveling on foot and by following the water courses, aerial photographs of one district in northern Ontario revealed more than 3000 lakes that had not been shown on any other map of the region.

Forestry sketching is another highly specialized part of aviation which



Above: Map made by surveyors who traveled overland and by canoe, charting the major watercourses but missing many smaller lakes, rivers, and other characteristics. *Left:* The same region mapped with modern aerial photographic surveys

Canada has promoted to the utmost. A sketch map to show the location of timber of various types is made by a specially trained forester who, by means of signals to the pilot, controls the operations of the plane. Seated in the observer's hull of a flying boat, he can chart various types of timber on as accurate a map of the district as is available. This map, or sections of it, are placed in front of him in his cockpit and as he flies over evergreens, soft woods and hardwoods, burns and muskeg, he can sketch these features on the map. This type of sketch does not do away with the customary ground surveys, but it makes possible a faster and cheaper method of operating. From 30 to 300 square miles can be sketched in an hour, at a cost varying from one to ten dollars a square mile. Such a sketch map, made before a ground survey, also shows the best canoe trails and any regions of burnover which need not be investigated.

It will take many years to complete the aerial mapping of Canada's northland, not to mention its settled areas. The Dominion, it is said, leads the world in aerial cartography, having found this method of mapping its territory accurate, cheap and fast.

Our Army's Mechanized Force

The Tank Promises to Force a Reorganization of Armies for It Is Now Much More Formidable Than During World War Days

By LEVIN H. CAMPBELL, Jr.*
Major, Ordnance Department, U. S. Army

IN common with the industrial activities of the world, the Army is tending more and more to the use of machines in its organization. Mechanization as applied to the Army is defined as being the "Application of mechanics directly to the combat soldier on the battlefield." The modern machine gun and other automatic weapons quickly forced a stalemate in the World War. It soon became practically impossible for the infantry soldier to advance against the machine gun without incurring enormous losses. In an effort to overcome this condition the British evolved the tank. These machines produced in the hurry and stress of war were, of course, mechanically imperfect and left much to be desired in the way of speed and reliability. Even so, their use met with a very considerable degree of success.

Since the World War, great strides have been made in the design and construction of tanks and self-propelled track-laying vehicles of all sorts. As mechanical perfection and high speeds in such vehicles are being reached, it is quite natural that the Army should be engaged in an intensive study as to the best method of employing these types of weapons.

During the World War, tanks advanced with the infantry and, at infantry speed, became easy targets for the opposing artillery. Marching with the infantry, their tactics of employment were necessarily limited and circumscribed by the tactics under which infantry was used. Now that speeds as great as 20 miles per hour with track-laying vehicles are possible, a new method must be evolved if the maximum value is to be attained in the use of such vehicles.

The mechanical dependability of the vehicles to be employed in a mechanized force has been greatly increased since the days of the World War. The war-time tank usually covered from 50 to 60 miles before a complete reconditioning was necessary; the new light tank recently completed a test run of 2000 miles before overhaul was necessary. The speed of the war-time tank averaged about three miles per hour while the average of the new light tank during the 2000-mile test was 12.5. The increase in dependability is thus strikingly apparent. A tank may be expected to cover approximately 50 miles during a major engagement.

Such performance specifications of the modern track-laying fighting vehicles make it obligatory to separate them from the infantry in their battle operations if the full value of a mechanized force is to be developed. The matter is quite analogous to the high-speed scout cruiser in its relation to the slower-speed battleship. To tie the scouting force to the battle fleet would serve largely to nullify the efforts of the former in contributing to the success of a naval action. The infantryman in his advance invariably makes use of all covered approaches afforded by the terrain in his attempt to escape hostile fire. The armored vehicle, however, must depend upon its speed and its armor protection for its effectiveness, and will, therefore, select the best terrain within the battle area for its operations. Thus, while the objective of the infantry and of the mechanized force may be the same, it will often be desirable to employ them in different sections of the battlefield. The infantry will be a force of one kind and the armored fighting vehicles will be organized into a unit of a totally different character.

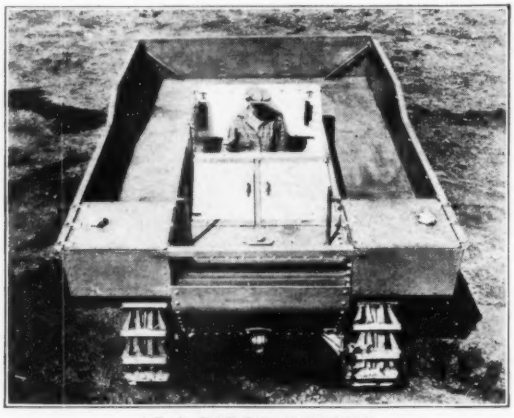
The underlying thought in connection with the employment of a mechanized force is based upon the formula: M times V^2 divided by 2, in which M may be taken as the mass of metal thrown from the guns of the vehicles and V as the velocity or rate of movement of the force. A light tank com-

MAJOR CAMPBELL shows here what the Ordnance Department has accomplished and what it hopes to do toward perfecting the weapon that promises to revolutionize land warfare. Since this was written, however, the Army has tested a newer tank which has given a spectacular performance—see the SCIENTIFIC AMERICAN Digest of this issue. Given time and money and the full co-operation of the automotive industry, the department may be expected to develop a mechanized force for the United States second to none other in the world.—*The Editor*

*See "Among Our Contributors," page 197.

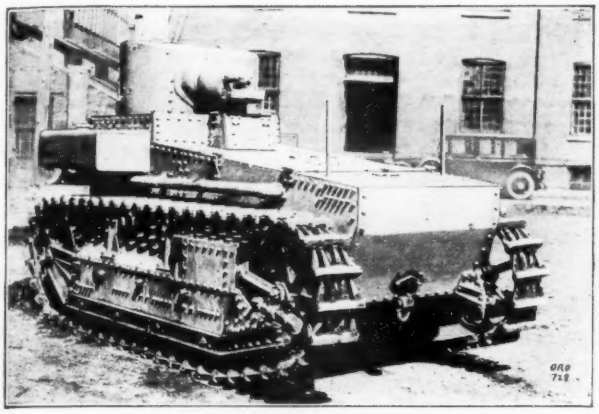
THE LIGHT TANK CHASSIS

The T1E1 chassis on which may be mounted either a light cargo body, a 75-millimeter gun, or the fighting tank hull with its complete armament



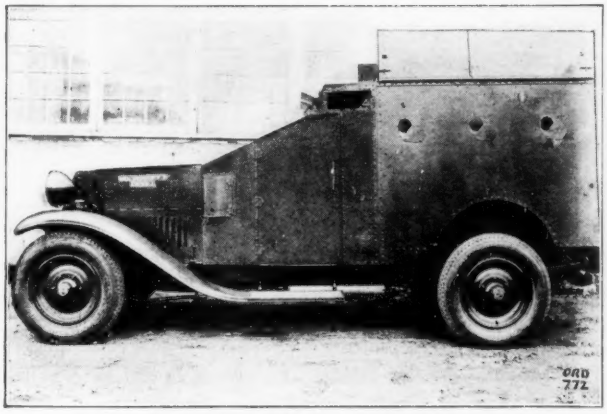
AS A CARGO CARRIER

The same chassis but with the cargo body which is used for transporting supplies and ammunition across country



THE POWERFUL TANK OF TODAY

Light tank T1E1. This machine is capable of traveling great distances without an overhaul, is speedy, and is powerfully armed



AN ASSISTANT TO THE TANK

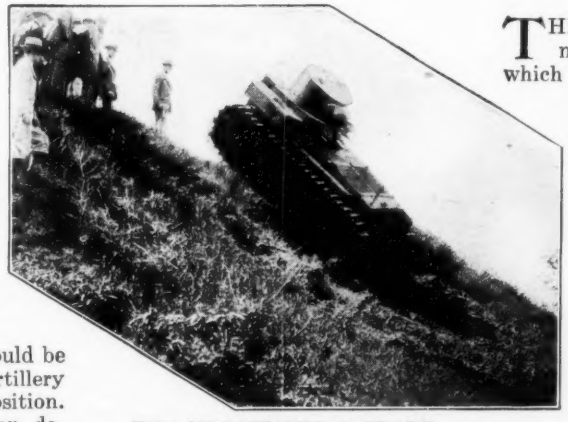
Armored cars such as this, built on a standard commercial chassis, will reconnoiter far in advance of the Army mechanized forces

pany, which comprises 24 tanks, is capable of firing approximately 6.7 pounds of metal per minute per man, as contrasted to an infantry rifle company of 256 men, in which the output is 0.41 pounds of metal per man per minute. Over favorable terrain the elements of the mechanized force may be expected to advance at the rate of 15 miles per hour with tremendous shock effect, as compared with a normal infantry advance of approximately one mile an hour.

It is increasingly evident, therefore, that a mechanized force must, for purposes of attack, be a self-contained unit. It must possess within itself high-speed reconnaissance, high-speed attack in the battle, high-speed vehicles to afford supporting fire for the attack wave, and high-speed armored vehicles to carry its machine gunners and automatic riflemen forward to occupy and hold the objective which has been reached in the advance. The armored vehicle itself is not well adapted to serve as a holding force, as due to its size it presents a target which would be readily demolished by enemy artillery fire, should it take up a fixed position.

The vehicles which have been developed, as well as those which should be developed and united to form a mechanized force, will now be briefly touched upon. If it were possible to use only vehicles found in commercial production, the ideal would at once be attained; the idealistic requirement that all items of equipment for the Army should be available or readily produced in time of war would be fully met.

THE Ordnance Department maintains close contact with the developments of automotive industry. Unfortunately the commercial world does not require high speed track-laying vehicles such as the tank, the self-propelled gun mount, the armored infantry carrier, and other types of vehicles which will properly be found within a mechanized force. The specifications must, therefore, be set up by the using services, and the Ordnance Department must produce the special vehicles thus required. However, we can and have gone a long way in reducing the war production difficulties, in the development of a track-laying chassis which is readily adapted to a wide variety of uses. This light tank chassis, T1E1, carries interchangeably, with relatively few modifications, a tank body with armament; a 75-millimeter gun; an ammunition body which also serves to carry spare parts, gasoline, oil, et cetera, portable bridge equipment, Signal Corps wire, machine gun mounts for anti-aircraft fire, the Chemical Warfare Service smoke shell mortar, et cetera. By the use of such a chassis, the production and field maintenance problems are greatly lessened.



T1E1 NEGOTIATES A GRADE

Up hill and down hill, the modern tank rumbles, dealing death and destruction

Funds have not yet permitted of the development of the armored infantry carrier, but such a vehicle does not offer any great difficulties in design. After the tanks, supported by the self-propelled accompanying artillery, have gained the objective sought, it will, of course, be necessary to occupy the territory with machine gunners and automatic riflemen in order to ward off enemy counter-attacks. These little armored infantry carriers which we have in mind will be for the purpose of transporting such gunner squads behind armor protection to the line which it is desired to hold. The speed of the vehicles will be at least equal to that of the light tanks, and the weight will be held as light as dependable design will permit.

THE 75-millimeter gun will be mounted on the light tank chassis which will have the speed of the light tanks engaged. Supporting fire for the tanks will, therefore, be always at hand. Ammunition will be supplied to these guns by the cargo carrier.

In an effort to assure control of this rapidly moving force by the commander, wire reels will be mounted on one of the track-laying cargo carriers so that the laying of signal and telephone wire may keep up with the advance. A command tank, in which the force commander will ride, will be developed with the light tank chassis as a basis. Control will also be assisted by the radio tanks on this chassis. Only by actual maneuver under variously assumed battle situations can the equipment, and the technique of control, be worked out.

In strategic movements of the mechanized force over great distances it will be far more economical to carry the various track vehicles of the force on wheeled trucks or trailers. For this reason the weight of each of the various units should be held to that within the capacity of the commercial truck. It is quite true that the new light tanks completed a road march of 145 miles in two days at an average speed of

MUD IS NO HINDRANCE

The light tank fords streams, and turns without hesitation in very heavy mud

10.5 miles per hour during the summer of 1928. We must bear in mind, however, that the hard road is the element of the wheeled vehicle rather than that of the track vehicle, and, therefore, use of wheeled transportation for great distances should be axiomatic. When the track vehicles have arrived at their immediate theater of operations, they will leave their wheeled transport and carry out their battle mission. The trucks will then be sent back to the base and will return with the necessary gasoline and oil to permit an extended maneuver by the mechanized force. The supplies will be unloaded at the side of the road, and the track cargo carriers will carry forward from that point.

ALL marching columns in the next war will be subject to attack by hostile planes. A vehicle of great usefulness within the mechanized force will be found in the self-propelled multiple machine gun mount on the T1E1 chassis. These multiple machine gun mounts will serve to hold the planes at a greater altitude, which will make their bombing and machine gun operations less effective. The mechanized force, being composed entirely of track-laying machines, can, upon the approach of hostile planes, immediately leave the roads and present a widely dispersed target to the attacking planes. The anti-aircraft machine gun mount will also be used against ground targets.

In adopting and organizing a mechanized force, the Army is merely paralleling industry in its effort to increase the fire power of the individual engaged. As previously stated, the fire power of a light tank company composed of 112 men is approximately 16 times that of an infantry rifle company composed of 256 men, as expressed in pounds of metal thrown per man per minute. We must add to this figure the great loss of morale produced by an armored vehicle rushing at high speed toward the enemy troops. No longer will the machine gun be able to hold up the advance, as the tank will be impervious to its fire. Indeed, it will be difficult to hold the machine gunners to their post in the face of such an assault. It will be impracticable for field artillery guns to register upon the fast-moving mechanized force, which will normally launch its attack as a surprise. The self-propelled 75-millimeter gun mounts will closely support the attack of the tanks with their fire, as they can be moved forward from one position to another in a minimum of time and at the speed of the advancing tanks.

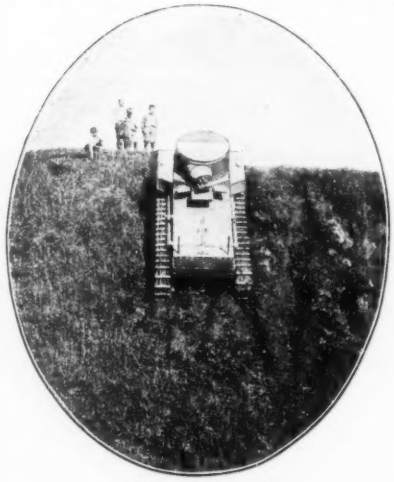
After the objective has been gained by the tanks and the ground occupied by the machine gunners, who have been carried forward in the armored infantry carriers, these supporting guns will assist in beating off enemy counter-attacks. They will hold their position until relieved by the wheeled carriages of the field artillery. The operation of the mechanized force requires a lesser number of men, and consequently the battle losses will be very materially less. The personnel will be protected by the armor and speed of their vehicles, and their objectives will be gained in much less time.

THE mechanized force will secure reconnaissance by the use of attached airplanes, by its wheeled armored cars operating over improved roads, and by its tanks. An accompanying photograph shows the latest type of armored car which consists of an armor plate hull on a commercial passenger car chassis. These cars will operate normally far out in advance of the mechanized force and will reconnoiter the highways to the front. Track-laying vehicles will comprise the entire combat units of the force. Under favorable conditions of dry ground, the wheeled vehicles will leave the road and operate cross country. The necessity of military operations in time of war is, however, unfortunately not limited to fair weather and dry ground. The track-laying vehicle possesses the greater ability successfully to negotiate soft ground than any other man-made machine applicable to the armored force.

The mechanized force will have no vehicle within its combat organization which does not measure up to the requirement that it contain within itself the full limit of the art as regards cross-country mobility. There is no question but that wheeled vehicles are much more economical in operation on hard roads than are track-laying vehicles. The primary sphere of operation of the mechanized force is not, however, on the roads, but rather *off* the roads. Consequently it will be composed of vehicles of the most efficient types designed to execute the recognized purpose of such a force. The illustrations of the light tank operating over typical terrain of mud and grades, show the necessity for track-laying vehicles.

THE ideal combination in a vehicle is one that will permit of efficient operation both on the roads and cross country. Such a combination is to be had in a wheeled vehicle which is adapted to receive a track over and around all of its wheels when operating off the roads. Much time and money have been spent both here and abroad in the development of such a combination. The necessity for the use of such a vehicle within the mechanized force may be developed, and if so it will doubtless follow that the engineering ability to be had will evolve a satisfactory machine.

For reconnaissance well to the front of the mechanized force, a possible combination is offered by using a commercial truck to transport the light tank. One tank can be carried on a commercial truck, while another is carried as a trailer load. While traveling on the road, should a more detailed reconnaissance to either flank be required, the tanks are run down off the truck and trailer and then proceed under their own power to gather the information desired. The reconnaissance is made behind armor plate protection and at a relatively high speed. Upon accomplishment of the immediate mission the tanks return to their carriers, and reconnaissance is carried farther to the front. The advantages of using such a combination lie largely in economy in the use of available vehicles; the commercial truck on the one hand, and the light tank, a component part of the mechanized force,



OVER THE TOP

Testing a light tank. The motor of this tank is powerful, speedy, and efficient

on the other. These two vehicles must in any case be provided for other necessary uses within the Army.

The weapons of the soldier of the mechanized force will be the machine gun and the automatic rifle while the tanks will be equipped with semi-automatic cannon. The force will thus have within itself the maximum of fire power as expressed by the most modern weapons.

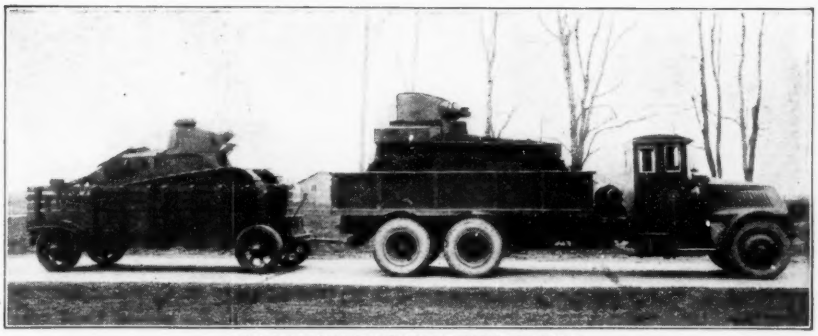
The force, with its mobility and fire power, will prove most valuable in advance and in rear guard actions. A practically uninterrupted advance of the main body will be assured by its use in the advance guard, until such time as serious enemy resistance is met with. In its function as a rear guard, the enemy's pursuit will be sufficiently delayed to permit of the uninterrupted and unharassed retreat of the main body. The great speed of the mechanized force will make it of particular value in turning movements and in enveloping the enemy's flanks.

THE medium tank of 15 tons in weight is too heavy for truck transportation, and as such will not be a part of the mechanized force. Medium tanks will be attached upon occasions when heavy resistance is to be overcome. With their heavier armor and three-pounder semi-automatic guns they will lend greater striking power to the force. Their speed will be sufficiently high to advance at the rate set by the other units of the mechanized force. The Chemical Warfare Service smoke-shell mortar, when mounted on the light tank chassis, will be an important unit with the force. Losses in both matériel and personnel will be greatly lessened by the correct use of smoke in the battle.

A mechanized force will most certainly not revolutionize warfare; it will prove but another weapon of great power at the disposal of the commander. Obviously, changes in tactics must be made to incorporate the force correctly within the Army. Not until such a force has been organized and equipped with modern vehicles can its full use be understood and appreciated. We may all theorize, and we are all entitled to our individual opinions, but the following words of Admiral Mahan seem to be particularly applicable to this whole subject of mechanization:

"The student will observe that changes of tactics have not only taken place *after* changes in weapons, which necessarily is the case, but that the interval between such changes has been unduly long. This doubtless arises from the fact that an improvement of weapons is due to the energy of one or two men, while changes in tactics have to overcome the inertia of a conservative class; but it is a great evil. It can be remedied only by a candid recognition of each change."

Many people, through lack of opportunity for observation of modern automotive equipment applicable to Army uses, are prone to judge tanks and other armored vehicles by the performance standards of the war-time vehicles. This leads to gross errors in evaluating the possibilities of the situation. We all recognize that the automobile of 1929 is a vastly superior car to that of 1916. The present-day armored fighting vehicle may be considered in the same manner. The statement has authoritatively been made that even in the case of World War tanks the casualties of the Tank Corps were the lowest in percentage of men killed compared with total casualties in other arms. If those crude machines served to lessen the battle losses, surely those of this modern day will be even more effective.



RAPID SERVICE TO THE FRONT

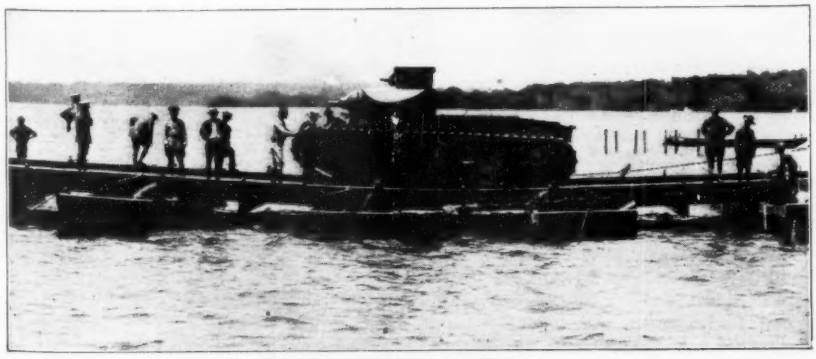
A commercial truck with trailer moving two light tanks at high speed over improved roads. In the eight-ton truck is a T1E1 light tank while in the 10-ton trailer is a six-ton light tank

During the summer of 1928 a small force, equipped with motor transportation and tanks, was assembled at Fort Leonard Wood, Maryland. The equipment was largely of war-time construction which, in large part, precluded obtaining the correct picture of the capabilities of a modern force. Many valuable lessons were learned, however, and a start in the right direction was made. When funds become available for the supply of modern equipment, the full possibilities of such a force will be recognized.

A committee of eminent engineers of the Society of Automotive Engineers, has, since 1919, been of great value to the Army. All of our automotive projects have been submitted to its members at bi-annual meetings, held usually at some great plant of the industry. We have received constructive criticism and helpful advice and we have been given access to the latest developments in the automotive industry.

AS great as is the wealth of our country, we cannot afford to keep a military establishment equal to that which we will require to prosecute successfully a major war. We can afford, however, to equip and maintain a small modern mechanized force, which will serve as a laboratory for the development of machines and the training of personnel in the tactical employment of such an arm. To the establishment of the Army charged with the design and procurement of such vehicles in time of war, the peace-time development of but a few of these vehicles will be of advantage in reducing the time required to reach quantity production.

We should not wait until the ideal is reached in automotive development. Such will never be reached in an industry which is making such rapid strides. We should not be deterred from entering into the procurement of the necessary vehicles for a well-organized and well-equipped mechanized force. We should make a start; the developments and logical improvements will rapidly follow.



UNDER ITS OWN POWER

A medium "A" tank, model 1921, crosses a pontoon bridge in a test. Since this tank weighs 23 tons, the crossing test showed the feasibility of such tactical maneuvers in actual warfare

What Becomes of the Star Light?

The Stars Send Out Their Light into Empty Space. Does It Go On Forever? If Not, Where Does It "End"?

By HENRY NORRIS RUSSELL, PH. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

WE ordinarily speak and think of the night as dark. But the darkness of one night is very different from that of another. When the clouds are thick, and hang heavy over the sky even in the day, the night may be very black. But even then there is a difference between the darkness under the overcast sky and that of a closed room. One can hardly imagine a night so dark that an open door or a window giving upon the sky would be wholly invisible if one were in a cellar.

But on a clear night, although the moon is quite out of the way, things are altogether different, and the sky sends us a really very considerable amount of light. Anyone can realize this when he thinks how black the dense foliage of a tree appears against the summer sky. Most of the light comes, not from the stars which are separately visible, but from the background. Indeed, this is bright enough to dazzle the eye—strange as this may seem—and to make the stars look less brilliant than they otherwise would.

We all know how a star seen through a small chance gap between the leaves of a tree looks far brighter against the dark background than it would on an open sky. A more precise test of this effect was made years ago by Curtis at the Lick Observatory. He found that by viewing stars through a small hole in a large black screen many feet away, objects could be seen which were less than one fifth as bright as the faintest which could be detected directly, even in the clear mountain sky.

THIS background light of the sky comes from three main sources. Part of it reaches us from the telescopic stars too faint to be seen separately with the naked eye; another part comes from diffuse matter, probably meteorites, scattered through interplanetary space and illuminated by the sun—an extension of the zodiacal light; while the rest arises in our atmosphere as a faint but permanent auroral glow.

The careful work of van Rhijn indicates that five sixths of the light of the sky on a clear moonless night comes from the last two sources—diffuse matter and glow in our atmosphere—so that if we could get outside the earth's atmosphere, and what is more, beyond the sun's attendant fog of sparsely scattered meteorites, we would find the stars standing out on a far blacker background than earthbound mortals can ever hope to see. The Milky Way, instead of appearing about twice as bright as the sky remote from it (as it does to us) would be ten times as bright; and the dark nebulae which lie in front of it would be far more conspicuous than they are now.

If we could thus escape into interstellar space we would none the less find it far from dark. The stars in a hemisphere of sky give fully 500 times as much light as a single star of the first magnitude, or about 1/600th of the light of the full moon, and this would be light enough to enable eyes like ours to pick out a path pretty well if the light from the sky were not obstructed by atmospheric or other obstacles.

NO place in space within the confines of the galaxy is really dark, unless it is artifically darkened by the interposition of some barrier—whether a cloud, the roof of a cave or a man-made enclosure—between it and the vast light-filled spaces without. Even if we should flee in imagination far beyong the Milky Way—beyond interstellar into inter-nebular space—we would not find it utterly dark. If all the light which we received from the galaxy could be blotted out, leaving only that which comes from the extra-galactic nebulae, we would still get at least 1/10,000th as much light as we do now from the galactic stars, and probably about 1/1000th as much. A white surface lighted on one side by the nebulae alone would be illuminated about as much as by the rays of a star of the second magnitude. This is pretty faint; yet a normal human eye, if rested in perfect darkness for 10 or 15 minutes, can see a white object lit only by such a star.

To find a perfectly dark region of space we would have, therefore, to go beyond the region where the nebulae are scattered—that is, beyond the utmost limit of vision of the greatest telescopes—if we did not bury ourselves in a dark nebula and shut out the heavens with its opaque cloud.

Whence comes this light which fills space, and whither is it bound?

A child can answer the first query: "From the skies, of course." But no man can yet make bold to reply with assurance to the second. Some things we know—or can at least deduce from the observed facts. The light which escapes from the stars *keeps on going* (unless stopped by the accident of falling upon matter), ever onward with its prodigious and unalterable velocity, and there is no interference or confusion between the light of one star and of another. This second point deserves a word of comment.

If we should think of light as consisting of rays joining the stars through our eyes, or even the particles moving along these ray-lines, we might question what would happen if two rays intersected or two particles collided. But the newest physical theories confirm the conclusion of the older ones that light, when under way in empty space, behaves as waves would do. We have all seen how one set of waves on the surface of still water may cross another, and each set pursue its way unaffected; and we shall do better to think of light under this image than to picture it in terms of rays or particles.

STRICTLY speaking, we do not *know* anything at all about light on its travels in empty space. We can obtain knowledge only by catching the light on some material body. But these observations have never shown any indication that the light coming from one body interferes in any way with the light from another. Light from many thousands of stars together enters simultaneously into the lens of one of the great modern astronomical cameras, and the light of each star is brought to its own proper focus unaffected by that of any of the rest.

Nor is there any evidence that light is weakened in its passage through space. It spreads out, of course, in ever widening spheres. But there is good reason to believe that the whole amount of energy which these expanding waves carry suffers no perceptible diminution after a journey of a million years.

But does the light go on *forever?* The question is by its very terms beyond the power of observational science to answer. It is however, a legitimate subject for speculative thought, and the question is asked so often that something may well be said about it here.

Many different answers are imaginable. First; space may be infinite

in extent and the radiant energy may simply fly on and on forever, spreading out into the boundless abyss. This is the simplest of all answers, and for all we know it may be true.

Second; space, although without boundaries, may return into itself (as the surface of the earth or of any sphere does) and the light, after having gone "around the world," may come back. It is not a serious objection to this theory that a good deal of mathmatical training is required to understand what it really means. But a difficulty arises when we think that in this case we should be able to see at least some of the most luminous of celestial bodies—like the great nebula of Andromeda—by light which has gone "around the world" the long way as well as by the shortest path. This should give us a faint small image of the nebula at a point in the heavens exactly opposite to that in which we see it directly, and no such faint nebulae have yet been observed. This does not prove that the hypothesis is wrong, but only that it is a very long way around the whole circumference of space if it is curved. For the present the question must rest unsettled.

Third; the light may be stopped by falling upon dark matter scattered diffusely through space. The dark nebulae show that this actually happens in many regions within the galaxy, and similar obscuration occurs in the outer parts of spiral nebulae. Whether there is a thin haze of "cosmic dust" all through space we can not as yet determine. It is entirely possible that there may be; but light is evidently able to come pretty freely to us from the remoter of the great nebulae, so that the "mean free path" of the radiant energy before it is obstructed must be many millions of light years. This suggestion does not, however, go to the root of the problem, for such dark matter can not continue indefinitely to absorb the energy which the stars radiate to it without getting hot, or at least warm, itself. It will then radiate out energy on its own account and in time a balance will automatically be struck between the income and outgo. The dark nebulae, therefore, can in the long run act only as relay stations for the radiant energy, and after tarrying awhile it will again be on its way. Our eyes with their limited range may be no longer able to see it, but it will still be

"On the old trail from star to star
"A wanderer and a vagabond."

Last; the radiant energy may in some way, of which we can gain only the vaguest conception, be arrested on its way and turn back into the equivalent of energy—material atoms. This is a bold speculation, but many distinguished mathematicians and physicists favor it. There is strong evidence that the reverse process—the breaking down of ordinary matter, with the appearance of the enormous amount of energy which, on Einstein's principles, is equivalent—actually happens inside the stars and keeps them shining. If this happens without compensation the material universe is indeed decaying, and pouring its very substance out in floods of light into the inaccessible depths of space.

The hypothesis that the conversion of light back into atoms also happens is therefore necessary to a belief that the universe of matter and energy is really permanent in anything like its present form, renewing itself through perpetual change. This philosophical conception has been brought within the range of scientific study by Millikan's theory that the cosmic rays which he has studied so effectively arise from the formation of heavy atoms out of positive and negative electrons.

From Barnard's Atlas of Selected Regions of the Milky Way. Courtesy Carnegie Institution

"THE LIGHT MAY BE STOPPED BY FALLING UPON DARK MATTER"

Area, about 15 degrees square. Star clouds; also dark patches—of what? This is not positively known, but the evidence suggests that they are some kind of dark, diffuse nebulae

TO account for the presence of the latter in the otherwise empty depths of space from which he concludes that the rays must come, he assumes that they have been produced by the transformation of the light of the stars and nebulae back into the simplest forms of matter; and that this transformation occurs in the coldest and emptiest parts of space, while that of atoms into energy happens in the intensely hot interior of the stars.

It would be premature at present to pronounce decisively either in favor of this hypothesis or against it. The alternatives have not been exhausted, and some of the latest theoretical work on the absorption of very short waves by matter indicates that the cosmic rays carry even more energy than Millikan has supposed, and may result from the disappearance of stars rather than their formation. But this, too, is not settled.

For the present the narrator has only to review the various possibilities, and leave the reader to his own choice. That choice will probably be made—and quite legitimately—in the absence of positive evidence, on the basis of one's general philosophy. To some the idea of a universe that is running down, never to repeat its history, is abhorrent and the cyclical conception of the endless recurrence of new-born stars and worlds, although never twice just the same, is beautiful. Other people feel differently. The writer, who can hardly help expressing himself, is inclined to agree with Professor Eddington, both in his conclusion that the actual evidence indicates that the universe of stars is in "its first innings" and has not passed through the same history before, and in his comment, "I am an evolutionist not a multiplicationist. It seems so tiresome to keep on doing the same things over and over again."

Courtesy Packard Motor Car Company

SIX HUNDRED AND FIFTY MILES FOR $4.68

The cost for fuel for this Stinson-Detroiter Diesel-engined plane in a flight from Detroit to Langley Field, Virginia, was less than one quarter of that for the same flight in a plane equipped with a standard type of radial engine using the ordinary gasoline combustion system

Is the Airplane Diesel Practical?

A Summary of the Opinions, pro and con, of Men High in the Aeronautical Industry

By REGINALD M. CLEVELAND

IN the article presented here are the views of several men high in the aviation industry concerning the practicability of Diesel engines for airplanes. In the main, their comments are adverse to present use in the air of this engine which has so ably proved itself on land and water. It is a moot question, however, as is evidenced by the fact that, as the article points out, many manufacturers have been working for years to adapt the Diesel to airplanes. We hope, therefore, to be able to present in the very near future an article which will show what has actually been accomplished with these engines.

—The Editor

WHEN, last Spring, a Stinson-Detroiter monoplane flew from Detroit to Langley Field, Virginia, powered by an oil-burning engine designed for the Packard Motor Car Company by Capt. L. M. Woolson, new stimulus was given to a problem which has been engaging the attention of the engine departments of the airplane industry for a number of years—the adaptation of the Diesel type of engine to airplanes. The successful flight with this radial, oil-burning power plant, aroused intense interest not only among those present at the annual meeting of the National Advisory Committee for Aeronautics, but also among designers and engineers generally and the air-minded public at large.

It would be easy to argue, from the fact that this engine on this particular flight consumed furnace oil costing approximately $4.68 as against a normal cost for gasoline in a conventional engine of something more than 25 dollars, that new economies for general operation were definitely in sight. Such a conclusion, however, should not be arrived at with undue haste.

The advantages usually emphasized for the Diesel type engine for airplanes include:

Low cost of fuel.

Elimination of fire hazard, due either to electric ignition or to back-fires through the carburetor—since both ignition and carburetor are eliminated.

Decreased fuel consumption.

The possibility—not yet demonstrated in flight—of using a two stroke cycle with consequent low engine revolutions at moderate speeds, and a resultant increased efficiency of the propeller.

Elimination of interference with radio communication due to the absence of electric ignition.

Disadvantages frequently brought forward include:

Greater specific weight.

Higher first cost.

Difficulties of maintenance due to the fuel injection system used.

Objections to the fuel itself—probably somewhat readily overcome — on grounds of non-uniformity, lack of cleanliness, and less widespread distribution of supply sources.

It is admitted that the Diesel type advantages are highly desirable if they can be attained in a service engine fit for manufacture and production and for every day, all-condition use. On the question, however, of how close at hand the realization of such an engine actually is, there is by no means a meeting of minds among those best qualified to speak. It is a subject which is engaging the attention of leading aircraft motor manufacturers everywhere, both in this country and abroad.

THERE is one school of thought which holds that the dawn of the adaptation of the oil-burning principle to airplanes is near at hand. The Packard organization, with the record of successful test operation in the flight of the Woolson motor already behind it and with an expenditure said to be very large in preparation for the production of such an engine, is naturally of this school. C. M. Keys, for some time President of the Curtiss Aeroplane and Motor Company and now holding the same office in the Curtiss-Wright Company, resulting

from the recent merger with the Wright Aeronautical Company; of the Transcontinental Air Transport, and other important factors in the aviation field, recently predicted the use of the airplane Diesel type as a not distant development.

The General Motors Corporation in its purchase of the Allison Engineering Company, laid emphasis on this field of endeavor when Alfred P. Sloan, Jr., President of General Motors, in announcing the purchase, said:

"The Allison Engineering Company for some time past has been engaged in various developments of a mechanical nature and has recently been giving considerable attention to the development of aviation engines, including those of the Diesel type."

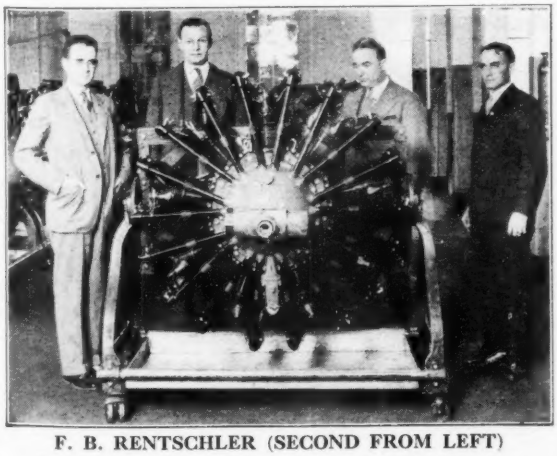
Courtesy Aeronautical Chamber of Commerce of America

C. M. KEYS

Mr. Keys predicts that the use of the Diesel airplane engine is a not distant development

IN Germany, Junkers and others are working upon the oil-burning type of engine and Junkers recently reached the stage of flight. In Great Britain, William Beardmore and Company, Ltd., of Glasgow, Scotland, have constructed a heavy-oil engine of the semi-Diesel type, giving interesting results upon the test block, and which, although not as yet designed for heavier-than-air craft, is intended for aeronautic use in the dirigible *R-101*.

In this country, every important airplane motor manufacturer may be said to be watching oil-burning engine development with the closest attention, and, in many cases, to be conducting experiments of his own. Among these, in addition to those already referred to, are Henry Ford, the Westinghouse Electric and Manufacturing Company and the Emsco Aero Engine Company of Los Angeles. The National Advisory Committee of Aeronautics is constantly pursuing its studies of the many problems arising in the design of compression-ignition motors suitable to aircraft.



F. B. RENTSCHLER (SECOND FROM LEFT)

"I can see . . . no likelihood that it (the Diesel) will replace the general type of motor which is proving satisfactory today"

With all this wide-spread interest and actual experimental research actively underway, there is, however, another distinct and definite school of thought which holds that the Diesel principle, however interesting, is by no means as yet adaptable to airplanes and may never be so in a wide sense.

F. B. Rentschler, President of the United Aircraft and Transport Corporation and its subsidiary, the Pratt and Whitney Company, manufacturers of Wasp and Hornet airplane engines, told the writer that he saw no reason to believe that the oil-burning engine would displace the present radial, air-cooled, ignition type.

"Fundamentally," said Mr. Rentschler, "the question of flight comes down to weight per horsepower. While there have been improvements in plane design and in airplanes, considered aerodynamically, since the war, the great forward strides have been primarily in motor efficiency.

"When the Wrights first flew, the motor weighed aproximately 16 pounds per horsepower. The plane was barely able to fly. Today, radial air-cooled engines have been brought down to one and one half pounds per horsepower. The flying ability of planes thus equipped needs no comment. The inherent nature of the Diesel type engine, with its increased compression and higher internal pressures, demands a heavy engine, and while reductions in weight may be effected by improvements in design and by the use of newer metals, I do not foresee that weight can be reduced to a point where the Diesel will be competitive with the standard radial engines of today.

"While it is of course desirable to eliminate—considering the matter from certain angles—fuel supply by means of a carburetor, this may also be done without going to the Diesel type. Direct or solid injection may be accomplished with the gasoline motor and interesting developments along this line of thought and with the super-charger are indicated by the experiments of some manufacturers.

"There are other objections to the oil-burning engine besides that of weight. I do not feel that the use of comparatively heavy oils will prove advantageous under the service conditions which airplanes must meet in flying as it is conducted in the United States. Even in summer at high altitudes, very low temperatures are recorded, while in winter, temperatures of 50 degrees below zero or less are not uncommon. In our various Canadian services such temperatures are considered standard. The behavior of heavy fuels under such conditions seems to me, to say the least, problematical.

"We are of course extremely interested in the Diesel development and are watching it closely in the domestic field and through our connections abroad. We have even experimented with designs of this type, but I am prepared to go on record as saying that I can see no need for its adoption at present nor any likelihood that it will displace the general type of motor which is proving so satisfactory today."

COMMANDER BRUCE G. LEIGHTON, Director of Sales and Service of the Wright Aeronautical Corporation, whose Whirlwind and other engines have blazed so bright a trail across the sky of aviation, also holds that the adoption of oil-burning engines for aircraft to any general degree, will not come soon.

"An airplane motor," he said, "must be considered as an integral part of the plane; not something which is attached, nor an external force. The problem is one of applying the units of energy contained in a pound of fuel with the least waste and most directly to the pound of pay load. When we fly, what we really are doing is to use the old principle of jet propulsion. We introduce raw fuel, combined in the correct proportion with air, into the motor, burn it and thereby cause the motor and, in turn, the propeller to revolve and the propeller, with its wide span becomes in effect a broad jet pushing out a stream of air. The wings are so designed as to make use of the speed thus developed to lift, not only themselves, but the power

plant and the pay load of the plane.

"Really, in the simplest terms, what we do is to make digestible to the motor, by cooking, the hydro-carbons contained in the fuel just as we make digestible, by cooking, the fuel for the human body contained, let us say, in a potato. The problem becomes one of

Courtesy Aeronautical Chamber of Commerce of America

COMMANDER B. G. LEIGHTON

" . . . I do not envision it (the Diesel) as an imminent, practical development"

making this cooking process as complete, efficient, and controllable as possible.

"The only essential differences between the Diesel type engine—and the engines so-called thus far applied to aircraft are not strictly of the Diesel cycle—and the conventional gasoline engine are that, in the one, raw fuel is injected into the compression chamber where it is mixed with air already drawn in and fired by reason of the high compression brought about by the design and travel of the piston, while in the other—the conventional internal combustion engine—fuel and air are mixed in predetermined proportions in the carburetor, supplied to the cylinder in vapor form, and fired therein by means of an electric spark.

"The internal pressures generated in the compression-ignition engine are so high as to necessitate a weight of metal which makes the whole engine roughly twice as heavy as the conventional type with its one and one half pounds per horsepower. The saving in fuel consumption of the oil-burning type is approximately 20 percent—by no means enough to compensate for the doubling in weight.

"Furthermore, there are many complicated difficulties about injecting fuel direct into the cylinder—the solid injection principle—which seem to me to militate strongly against this type of engine as a general service type or a production job. It is necessary, with solid injection, to put a very exactly measured charge into the cylinder at a very exactly determined time in the cycle of the stroke. Quantities must be exactly the same for each cylinder. With a 9-cylinder radial engine of this type, the variations as to time should not exceed one one-thousandth of a second, and the variations as to quantity must be held within almost equally narrow limits. Moreover, the quantity must be controllable as this control provides the entire throttle action.

"These complicated problems surrounding the injector pump have been met in *experimental* engines of both single and multi-cylinder types. But they seem to me to present a very real and serious objection from the manufacturer's point of view when it comes to production, and from the service point of view when one considers the variety of conditions, both natural and human, to which the modern airplane is subjected.

"We could doubtless turn out within a year an oil-burning multi-cylinder airplane engine which would fly from here to there. But, vitally interesting as the Diesel principle is, particularly if it should lead to a two-cycle motor, I do not envision it as an imminent, practical development."

Charles L. Lawrance, President of the Wright Aeronautical Corporation, is of the same mind.

"I adhere to the viewpoint," he said, "that such an engine is not yet right for wide-spread use. It is a decade away."

SOME interesting observations on the requirements of Diesel type engines for aircraft have been presented by C. H. Schowalter of New York University, before the American Society of Mechanical Engineers. Mr. Schowalter said in part:

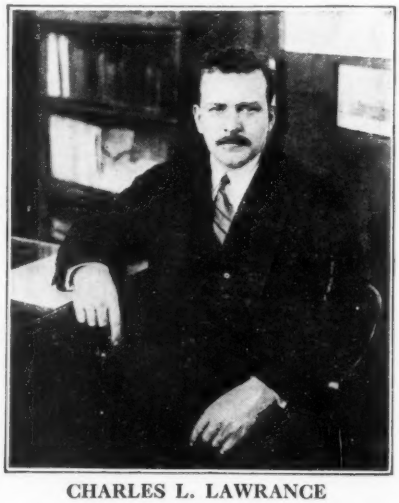
"Because of the outstanding success of the air-cooled carburetor engine, the buying public will be in favor of, and the design tendency will be toward, air-cooled Diesel aircraft engines. This method of cooling can, and is, being utilized in the design of both radial and in-line engines. In-line engines, however, need special cowling to direct the air flow.

"Any light-weight Diesel engine intended for the commercial aircraft market should not only be designed to meet the 50-hour endurance test required by the Department of Commerce, but should be able to operate many hours in excess of that limit. Extensive reliability and durability tests, under conditions of actual service, should be made before attempting to introduce it for general use. Vibration, lubrication, cooling, leakage through joints in the engine proper and in the piping system, should all be carefully checked. Performance of the engine should not only be checked under normal conditions but also under all abnormal conditions that could possibly be encountered in service.

"For cylinders of the size that would normally be used for aircraft purposes, the problem of fuel distribution and quantity regulation is of major importance. From the results of tests made by the National Advisory Committee for Aeronautics, the spray penetration and distribution for any particular size and shape of nozzle can be predicted. Combustion chamber and injection nozzle design can thereore be inter-related. The proper relation between these parts, and the design of the fuel supply and control mechanism are fundamental problems confronting the designers of light-weight, high-speed Diesel engines today.

"When using the Diesel engine, the main objection to the two-cycle carburetor engine, that of fuel passing out through the exhaust parts, is not present. An advantage of using this system, in the case of the Diesel engine, where reciprocating parts are of higher weight, is that with an explosion stroke for every revolution of the crankshaft, the inertia forces would be counteracted during each stroke and the crankpin more uniformly loaded.

"The effect of continued or sudden maneuvers, or of an abnormal flight



CHARLES L. LAWRANCE

" . . . such an engine is not yet right for wide-spread use. It is a decade away"

path, on the fuel injection system must be watched when this unit is being designed. Reliable functioning of this mechanism under all conditions of service is important, even though the airplane in which the engine is installed is not expected to be used for any except straight flying.

"Since the air-cooled carburetor engines have been developed to a high stage of perfection, through years of experimentation and use, it will be necessary for any aircraft Diesel engine that may be developed for the commercial market to duplicate its qualities of durability, reliability, and low weight per horsepower."

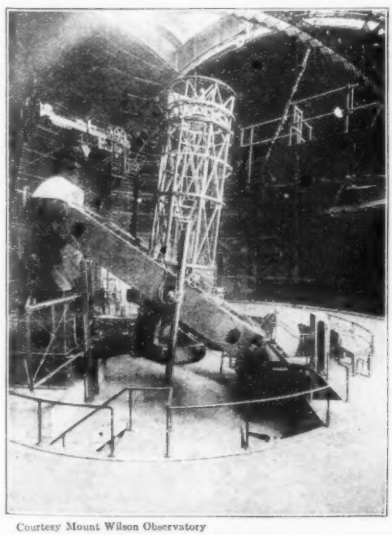
Silvering the World's Largest Telescope

A Witness Describes This Fascinating Process

OUR readers will recall that Russell W. Porter of Vermont, Corresponding Editor of this journal, co-author of the SCIENTIFIC AMERICAN book "Amateur Telescope Making" and in the last analysis the man to whom the American amateur telescope maker now owes the most, was called to California last year to take part in the design of the optical shops required for the construction of the much talked of 200-inch telescope, and to co-operate on the design of that great telescope and other instruments.

Mr. Porter has now spent several months in Pasadena, where the great telescope is to be made, as Associate in Optics and Instrument Design at the California Institute of Technology which is building the telescope in co-operation with the Mount Wilson Observatory.

RECENTLY he sent one of the editors a sketch and informal description of resilvering the 100-inch mirror of the Hooker telescope at Mount Wilson Observatory. This description seemed so vivid that his permission to publish it was obtained, and it was suggested that he illustrate it with a further sketch. This appears above. The first sketch, which may be seen on the front cover, was copied from Mr. Porter's pencil drawing and colored according to his specifications by our regular front cover artist, Mr. Howard V. Brown. Mr. Brown, by the way, is himself an amateur telescope maker and is thus twice an artist.



Courtesy Mount Wilson Observatory

THE GREAT TELESCOPE

The large man-hole to which Mr. Porter refers, here closed, may be seen, although only faintly, below the end of the tube

At Mount Wilson the silvering solution is customarily divided into two parts, and silvering is done accordingly in two stages. Mr. Porter's description follows:

"This morning I saw them silver the 100-inch mirror. They do this twice a year. You can imagine the 'kick' it gave me when they flooded the big disk with some three pounds of silver-nitrate in solution.

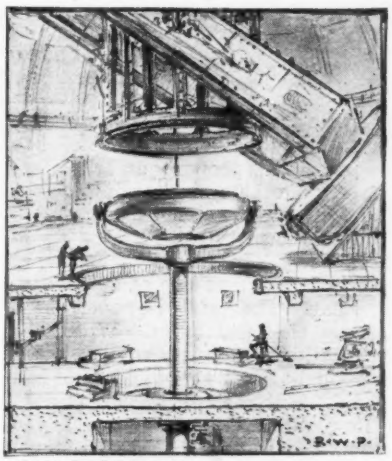
"It is a full day's job. They begin about four o'clock, unfastening the cell that holds the mirror from the tube. I arrived about nine, and they were then just starting to mix the chemicals. I asked Mr. Ellerman, the astronomer, why he had not taken photographs of this very striking operation and he replied that he never had the time, since he was so busy in charge of the proper mixing of the solutions. So I made the sketch, enclosed. (See cover.—Ed.)

"AS you probably know, the main floor has a large man-hole which is removed, and the mirror in its cell is lowered into a pit. To accomplish this there is provided a huge fork on the end of a plunger. This rises to the telescope tube, which has first been firmly anchored in a vertical position. The end of one of the anchor bars shows in the sketch. The bolts are removed, and down the whole affair goes like an elevator.

"The silvering process used is the one all amateur telescope makers are familiar with, that is, the Brashear process; except that all is on a grand scale. A band is drawn tightly around the disk. This band has a sluice-way on one side, with a wooden gate. The cell trunions rest in the fork, and this allows the mirror to be rocked through a small angle.

"The old coat of silver was first removed with acid and the glass given a thorough scrubbing with cotton swabs on the end of long sticks. This is the operation shown in the sketch—water is there being supplied through a hose.

"The solutions were prepared on the floor above, in four large square glass jars—one man to a jar. When they were ready to silver, the reducing solution was first poured over the disk, and half the silver (two jars) added. After a few moments the depositing solution was stirred and the flocculi were kept moving with the swabs. Then the rest of the silver was poured on. It was left on for half an hour, with constant stirring meanwhile.



Sketch by Russell W. Porter, M.A.

LOWERING THE BIG MIRROR

The plunger has risen to the 4½ ton disk, which was then detached and is descending to the pit, there to be resilvered

"Then the sluice gate was opened, the spent solution was poured off, and the disk was thoroughly washed. The band was removed and the surface dried with chamois skin. The chamois was 'flipped' to the center, dragged to the edge and wrung out.

"When dry the coat was given a hard scrubbing with absorbent cotton. Then a huge pad some three feet in diameter was attached to a 20-foot power crank-arm and the film was burnished with a circular stroke, the disk meanwhile slowly rotating underneath. The pad was covered with chamois charged with rouge, but it was first used with a cotton pad over it, and later with the chamois skin itself.

"THE entire operation of silvering this largest of all mirrors was carried through with clock-like precision. Some dozen men were employed and each one had his appointed task. While there was some good-natured banter back and forth, one could see that they took a warrantable pride in the work they were doing.

"The silver film was of the order of one hundred thousandth of an inch thick. I figure that this amounts to a cube of silver about three eighths of an inch on a side. This is a small proportion of the original three pounds—not much over 1 percent.

"I could not help, while they were working on the big disk, trying to visualize the whole affair increased to double its diameter, as will be the case with the 200-inch mirror. This will mean four times the area, and that will be some surface.—Porter."

Foiling the Burglar—III

The Invisible Guardians of Wealth Are Little Clocks and Disks of Metal

By ALBERT A. HOPKINS
Author of "The Lure of the Lock"

EVERTHING which deals with crime has interest. The burglar's "jimmy," his mask, his drills, his torches, his "soup," are never-failing sources of "copy" to the reporter, cub or otherwise. It is astonishing that there should have been no work of any importance on locks issued from 1852 to 1928. It is for this reason that we have run the series of articles entitled "Foiling the Burglar." Burglary as a profession is a losing one, not recommended for the younger generation and these articles have told why.—*The Editor.*

IN the first article of this series we saw how the banker early tried to protect his property and the property of others; we now develop the theme at greater length, presenting some unique pictures of a very essential industry. In the second article we described the "first line of defense"—the vault. The vault, however, is no stronger than its locks. When the combination lock was invented, bankers thought that the millenium had arrived. But their security was not of long duration, for, as we have shown, the so-called "masked burglar" loomed up behind every cashier's bed.

Thoroughly impressed with the gravity of the situation and the imminent danger of these new conditions, Mr. James Sargent, the celebrated lock inventor, oblivious of all other considerations, devoted himself, day and night, to devising and developing plans for a lock which even the custodian of its combination could not open until the predetermined time for unlocking.

HIS native ardor and the growing exigencies of the case became an inspiration to his genius, and his plans were speedily completed and without an hour's delay they were being embodied in a model; within a few weeks from the first stroke of a pencil in making sketches of the parts, a complete time and combination lock, combined in one case, was ready.

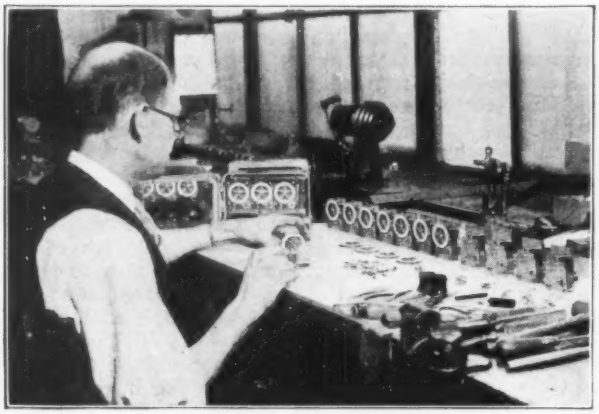
When burglars become convinced that it is impossible for bank officers to open their safes out of banking hours, there is no longer any inducement for an attempt to compel them to do what is out of their power, and when burglars are aware that a bank has a time-lock, the officers are secure against such assault. Even if taken to the bank, an officer can demonstrate that there is a time-lock on the safe, by asking his assailants to listen to the ticking of the timer, by placing their ears against the safe door.

All photos courtesy Sargent and Greenleaf, Inc.

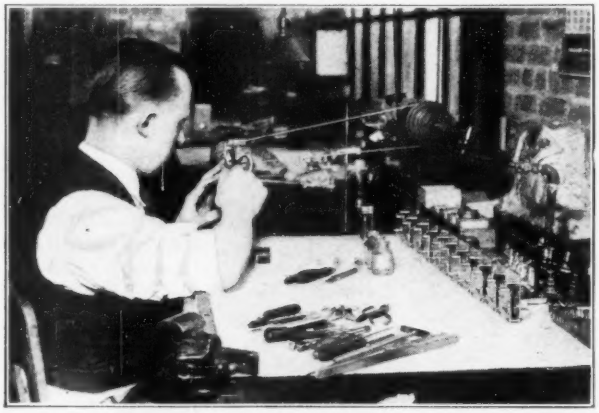
TIME LOCK PARTS COMPARED
The balance wheel is oscillated until it attains the beat of the master movement

In one instance, many years ago, a time-lock had been attached after banking hours on a certain day, and the safe locked up to open at a certain hour the next morning. The bank had no suspicion of any premeditated attempt to rob it, but, during the following night, a gang of masked burglars secured the cashier, took him to the bank and the leader ordered him to open the safe. He assured them that he could not open the safe because it was protected by a time-lock. This they indignantly denied, telling him that the leader was in the bank the day before, saw the door standing open, and that there was no time-lock on it. He informed them that it was put on only the evening before and that if they would place their ears against the door they would hear it tick. The leader listened for a moment, as directed, and, turning to his fellows, said, "It's no use, boys, here's another six weeks' job gone." They hastily left.

THE time lock affords the highest type of protection on a vault from the inside, for after a door is once locked it is beyond human agency to effect entrance until the fore-ordained time. Thus again the inventor has made the way of the burglar still harder. While there is life



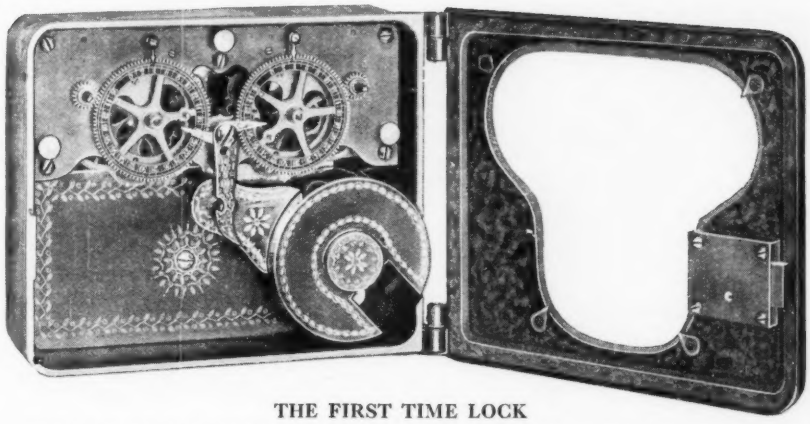
ASSEMBLING TIME LOCKS
The three or four movements are carefully assembled and put in their cases. Any of the clocks will free the bolt work on the door



SETTING THE JEWELS
The jeweling is done as carefully as in any of the finest watches. The jewels are spun into position with the aid of a burnisher

in the body, however, the cracksman will continue his nefarious proceedings although he could make a much better living with a tin cup and a glib tongue. Once a burglar always a burglar comes very near to being the truth.

The early time locks consisted of two movements and were usually connected directly with the combination locks; that is, the combination lock could not be operated until the time lock was run down. Now, time locks are used independently of the combination lock, or any other locking device on the vault door. They really constitute a secondary defense in the guarding of safe and vault door mechanism. The modern time locks are usually built with three or four movements. Each movement, however, is capable of doing the work alone. It may be of interest to know there is no case on record where a complete lockout was caused through the failure of a time lock.



THE FIRST TIME LOCK

The first time lock was sold in 1874 to the First National Bank of Morrison, Ill. In a short time there was a demand for similar locks for safes and vaults all over the United States

"LIMBERING UP" THE TUMBLERS

Giving the wheels or tumblers harsh treatment to show defects, also to free the complete set, making them run smoothly. No combination lock in actual use receives such severe usage

THE movements of the time locks are made with the same degree of accuracy as high-grade watch movements. They are sturdily built to withstand any shock, and are made throughout of corrosion-proof materials. As a regulating device on these movements is not desirable, it is necessary to time and adjust the hair spring at the factory with a great degree of accuracy. To accomplish this a special master movement and fixture was devised to time these hair springs. This is shown in one of our illustrations.

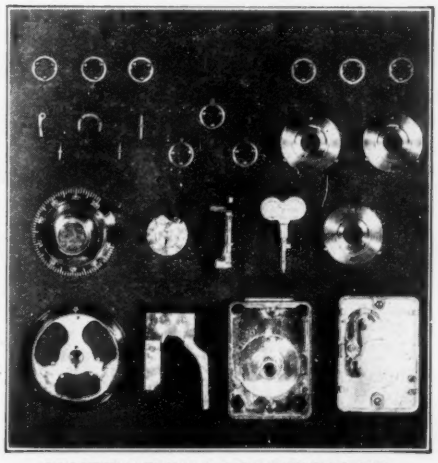
Our next illustration shows the method of setting jewels. All of the jewels are set in separate housings, and the jewels themselves are set in these housings by means of a watchmaker's lathe and special fixture. As the outside diameter of these jewels varies, the jewel itself is used as a gage for counterboring the jewel housing. The housing is then counterbored and the jewel is put in by means of hand tool and burnisher, thus being firmly spun into place. In the assembling department the various parts are assembled and put into the various cases. The movements themselves are largely standard, but they are made in a large number of sizes and cases.

In our first article we described and illustrated the essentials of the combination lock which, like all other articles of its kind, has passed through a period of evolution, and the modern combination lock is as different from the early type as the present automobile is from the 1900 model.

The first problem is one of strength. Therefore, every part of the combination lock must be designed with a view to the possible stresses to which it may be subjected under any conditions, and this work begins primarily with the patterns of the various parts entering into it. All stresses are carefully calculated and patterns are designed in accordance with these calculations.

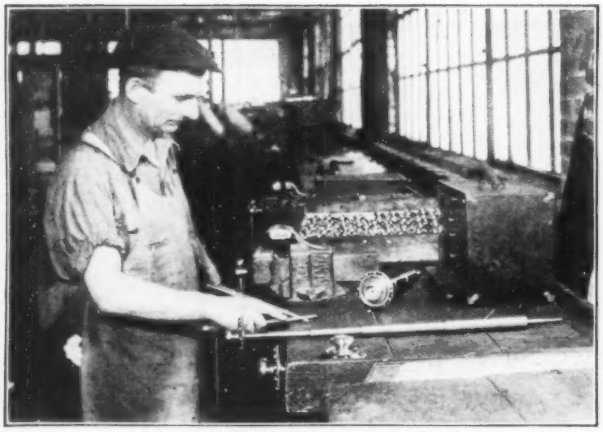
In high grade combination locks using three or four wheels, the changes are numerous. A three-wheel lock will give a possible million changes, and the four-wheel lock one hundred million changes.

AS a protection against forcible entrance, various means are used. The most common is the use of the combination lock in connection with what is called the burglar-proof spindle. This is a hardened steel spindle, made with various steps, to prevent the spindle either being driven in or pulled out. Usually this spindle is built directly into the safe or vault door by the safe maker. The inner end connects directly with the driving wheel of the lock, the outer end with the combination dial. Another precaution is to operate the combination lock by means of an "outside shaft." This is



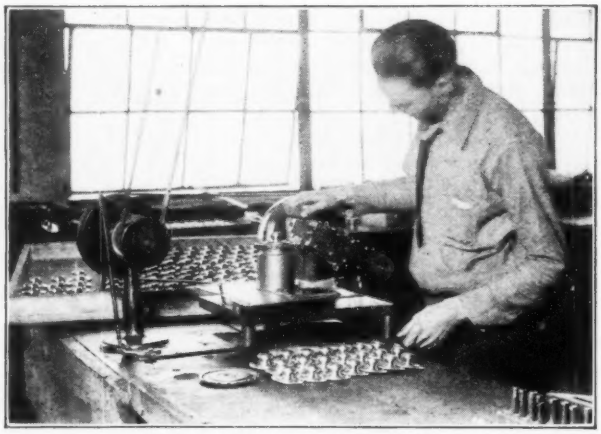
COMBINATION LOCK DISSECTED

Here we have all the parts of a key-changing lock laid out for examination on a board



FITTING SPINDLE AND DIAL

The spindle is made of high grade tool steel. The spindle is not all hardened uniformly. This prevents any breakage at the steps



GRADUATING THE DIALS

Most dials are black with white enamel. Square cut graduations instead of the ordinary V-shape give an anchorage for the enamel

an extension to the lock case, housing a series of gears, the spindle not entering directly into the lock.

In one of our illustrations is shown an interesting method of what is called the "limbering up" and testing of the wheels, this being one of the final operations. After the wheels are completely assembled and inspected, they are put together in sets, ready for the lock. The complete set is then put on a special fixture, the top wheel attached to a pulley, and the operator, by means of a strap, rapidly revolves these wheels back and forth.

Another interesting operation is the graduating of the combination dials. This is done in a special machine, and as the dial is completely turned up, it is mounted on the machine and the graduations are cut by means of the narrow cutter inserted in the head of the machine.

ONE of our illustrations shows a burglar spindle prepared for the fitting of the dial. This spindle is of the "pull-off" type. The dial may be removed from the outside at any time, and the end of the spindle is cut in such a way that the dial can only be put on in one way.

The spindle is made of high grade tool-steel throughout. Turned to within five to eight thousandths of the finished size, it is then hardened. The hardening itself is not uniform throughout the spindle, the spindle being left soft at the corner of each step to prevent breaking at these points. The spindle is then put into grinding machines and ground to a tolerance of one thousandth, plus or minus.

JUST as time and combination locks are intended for protection for the outside door of the safe or vault, so the safe deposit lock is a protection for the individual safe deposit box inside of the vault. The problems involved in the safe deposit locks are somewhat different from those of the time and combination locks. Aside from the protection afforded to the renter of a box, a good safe deposit lock should also protect the bank against unauthorized entrance into a box. The lock must also be so made as to require at least two persons—one an official of the bank and the other a renter—to open the box. In the early days of safe deposit vaults it was customary to place two ordinary key locks on the door. These were either set one above the other, or tandem fashion—that is, one behind the other—in which case the rear lock acted as a check on the front lock. the next development embodied the two complete lock mechanisms in the same lock case, which in its earliest form was a double nose lock with two complete sets of tumblers.

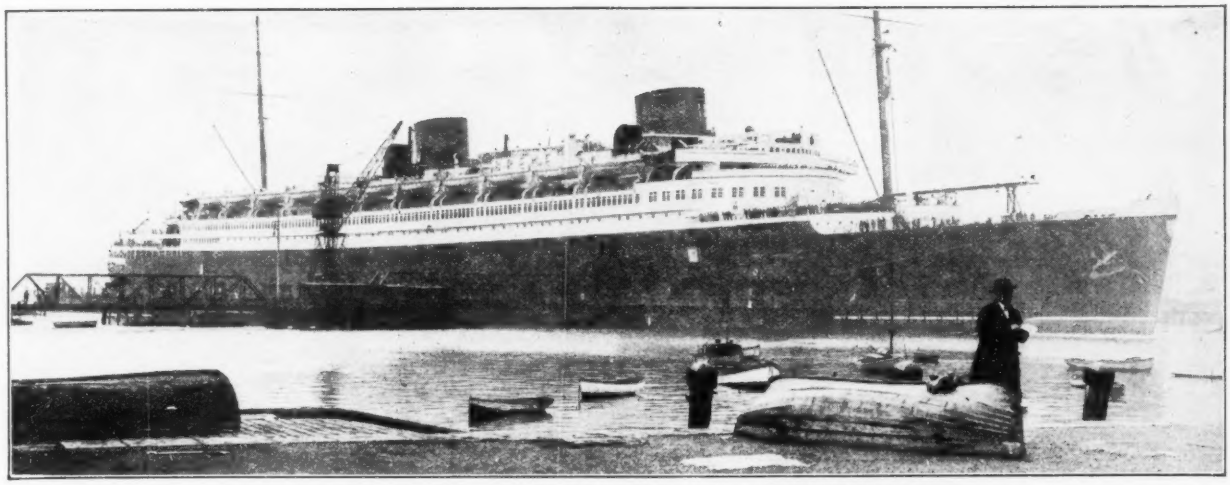
In the manufacture of safe deposit locks, particularly locks of the changeable type, the keys are the most important part of the lock. It is quite obvious that where there is an installation of 5000 locks, and 5000 sets of keys are furnished, every set must fit in one of the 5000 locks, and as the manufacturer has no means of knowing which particular set of keys will eventually be used with a particular lock, extreme interchangeability is, therefore, vitally important.

TO maintain the desired accuracy of these keys Sargent and Greenleaf found it necessary to build a special key cutting machine, which is shown in our illustration. This is a ten spindle machine, and will cut keys for locks having as many as ten tumblers in one pack. Because of the complete key being finished in one operation, extreme accuracy is insured, and the usual errors which occur when handling keys a number of times are avoided. The dials on the machine are graduated in accordance with the key code—the combination being read directly from the codes—and the dials set for each separate set of keys.

The writer is indebted to Mr. W. F. Diesel, Vice-President and Treasurer of the Rochester concern for many courtesies in connection with the preparation of the present article.

PUTTING SECRECY INTO SAFE DEPOSIT KEYS

The complete key is made at one operation. The dials on the machine are graduated in accordance with a key code. The dials are set accordingly for each separate set of keys



THE NORTH GERMAN LLOYD LINER "BREMEN"

This new German steamer, the longest merchant ship in the world, is equipped with up-to-date safety apparatus of all descriptions, and is an excellent example of progress in safety at sea. Her devices for launching lifeboats are second to none for efficiency and speed

Last Call for Sea-Safety Contest

THE competition for the SCIENTIFIC AMERICAN Medal awarded by the American Museum of Safety will close on September 30, 1929, so there is still time to send in designs or projects. The descriptions should be typewritten and in the English language and the drawings should be clear so that the members of the committee may readily understand the idea. Projects can be sent either to the American Museum of Safety, 141 East 29th Street, New York, or the office of the SCIENTIFIC AMERICAN, 24 West 40th Street. It is fortunate that at least two members of the committee of award were present at the second International Conference on the Safety of Life at Sea recently held in London, so that competitors may feel that their designs will be passed upon by experts who are fully abreast of the times. The principal designs of merit submitted, as well as the winning one, will be illustrated in the SCIENTIFIC AMERICAN as soon as the committee of judges has finished its labors.

It will be some time before we have the full text of the code just framed in London. During the period between the holding of the first conference, after the sinking of the *Titanic*, and the second conference, that met in the shadow of the *Vestris* disaster, conditions at sea were far from satisfactory. Rules for safety lacked uniformity among the maritime nations. Why this was so, Rear Admiral J. G. Tawresey, U. S. N., has explained:

"A number of governments that had participated in the conference, including the United States, failed to ratify the convention, and it never came into full effect. Further, the World War followed within a few months and resulted in all shipbuilding being taken over for the governments."

The foundering of the *Vestris* was due in part, it has been brought out, to defects in construction and her lifeboats were not all placed where they could be readily got at and lowered. It was high time that another safety conference should be assembled to bring order out of the complexities of regulation and draft; a uniform code to bind the seafaring nations of the earth is necessary.

THE United States delegation was carefully selected. "I feel safe in saying," remarked the chairman, Representative Wallace H. White, before going to London, "that there must be more extensive use of wireless on small ships." The Americans held that the problem of better designing of interior structure was the most important question that the conference would have to deal with. Load lines were bound to provoke discussion. Great Britain had long complained of the unfair competition of overloading by other European nations. As Mr. White said, the United States has been "open to severe criticism" until Congress enacted recently a law establishing load lines for American ships.

The bitter experience of the *Vestris* disaster showed conclusively that we had become careless about safety at sea. It is a tragic thing that some such accident always seems necessary to awaken us to the risks we run, but it would be even more tragic if, having the example of the *Vestris* before us, we failed to adopt the precautions which this expert committee advises.

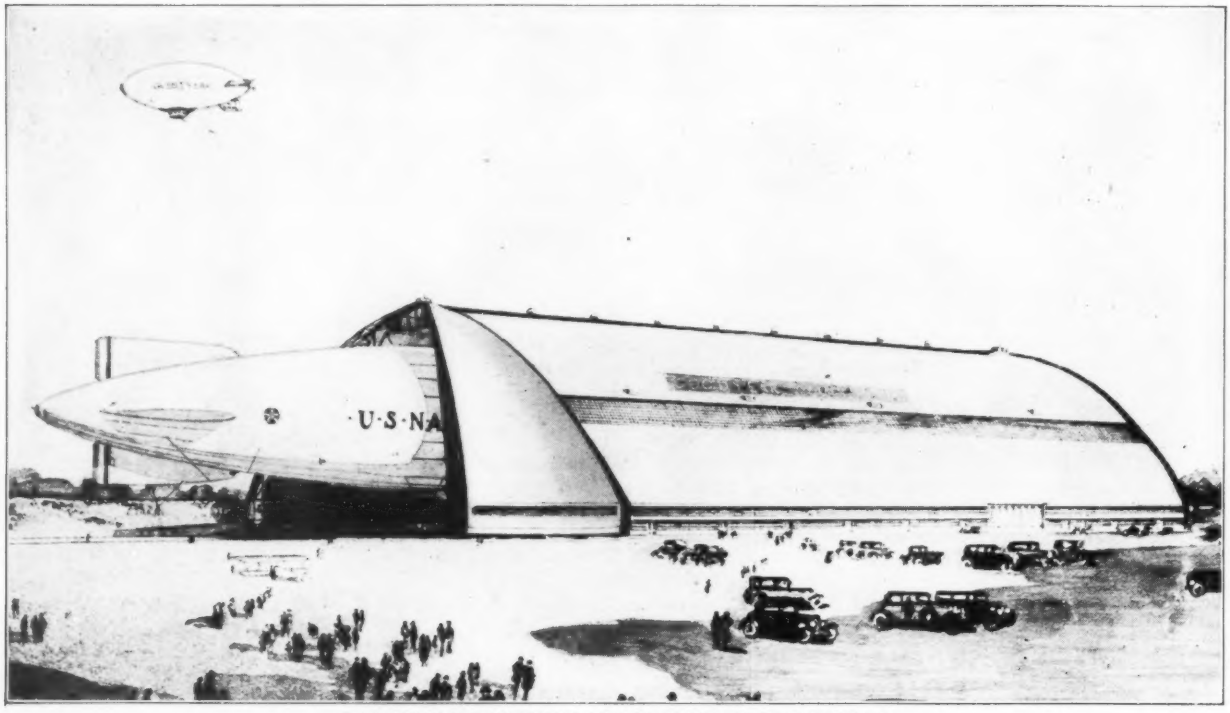
The creation of a corps of technical experts possessing qualifications as naval architects or constructors to pass upon the scientific construction of a ship has been recommended by Dickerson N. Hoover, Supervising Inspector General of the Steamboat Inspection Service. He revealed this plan in a radio talk from Washington, July 6, entitled "Protecting American Lives and Property on the Water." He would have the new corps established in his office.

"While it is true," said Mr. Hoover, "that today we conduct stability tests, these stability tests often penalize a vessel as a result of the ballast that must be provided as a consequence of the test. Much of this could be avoided, and also additional overhead in the cost of construction, if the plans of the ship were passed upon by the service before the ship is constructed. If that be considered too progressive, or a revolutionary idea, permit me to say that it is the practice that is today followed by the British Board of Trade."

Mr. Hoover stated that the plans of buildings are passed upon by municipal inspectors before they are constructed, and added that "what is logical in the construction of buildings is also logical in the construction of ships."

During the fiscal year 1928 more than 350,000,000 passengers were carried on steam vessels that are required by law to report the number of passengers carried; all of them were inspected by the service. Only 81 passengers lost their lives, while for each passenger lost, more than 4,000,000 were carried in safety.

"The Steamboat Inspection Service," Mr. Hoover said, "is striving hard for the zero mark, as a record in preventing the loss of human life on the water."



LARGEST STRUCTURE OF ITS KIND IN THE WORLD

The airplane carriers, *Saratoga* and *Lexington*, could rest, without their masts, side by side in the Zeppelin factory and hangar, of which this is an artist's drawing, now under construction at Akron. Its floor, 389,000 square feet, would hold six miles of box cars

The Zeppelin's American Home

Two World's Largest Zeppelins for Our Navy Will Be Built in Huge Hangar Now Arising at Akron, Ohio

By WALTER E. BURTON

ERECTION of the huge airship factory and dock in which the two Zeppelin-type Navy airships of 6,500,000 cubic feet gas capacity will be built is presenting a wealth of technical problems, the solving of which doubtless will prove of value to many fields of engineering. The building, situated at the southern end of the Akron, Ohio, Municipal Airport, will be the largest of its kind in the world. It has no pillars or other inside supports. It is to be, when completed, 211 feet high, 1175 feet long, and 325 feet wide. It covers eight and one half acres of ground.

Perhaps the most difficult—at least the most spectacular—phase of the building construction was successfully carried out recently when the central arch of steel webwork was raised into position. The feat attracted the attention of engineers in all parts of the world.

The two supports of the central span had been erected, each 100 feet high and 325 feet from the other. The problem was to raise the remaining portion of the semi-elliptical arch so that its base would rest on top of the towers. The weight of this span is 360 tons, its height being about 100 feet and its width at the base about 200 feet.

The two steel-beam supports having been completed, the remaining 360-ton span was assembled on the ground between them. At the top of each support, pulleys were placed, and over these, large steel cables were run. One end of each cable was attached to the portion to be raised, and on the other end was fastened a steel bucket containing scrap iron, the weight being about 36 tons. There were eight of these counterweights which served to reduce the weight to be lifted to about 72 tons.

FOUR railroad cranes with lengthened beams curved at the upper ends were placed so that one occupied each corner of the span. These cranes lifted the mass of steel into position, aided by the counterweights. But before this could be done, the tops of the supports had to be spread apart so that the center would slip into place unobstructed. Hydraulic jacks placed under a special falsework accomplished this.

On the day before the raising, the span was elevated five feet above the ground and allowed to rest there overnight, so that the cables would be drawn equally taut. At about 7:30 A.M. the following day, moving of the section into position was begun. Shortly after noon, it was being bolted to the supports. The intervening time had been spent largely in numerous conferences among engineers in charge, so that the actual time required to raise the arch was little over an hour. The work progressed without even a slight mishap.

It is significant that the Goodyear-Zeppelin Corporation had awarded contract for erection of the steel work of the factory to the American Bridge Company, for the constructing of one of the giant arches is very much like the building of a bridge. The engineer in charge of the work is W. C. State, consulting engineer for the Goodyear-Zeppelin Corporation. Plans for the arch, as well as for the rest of

the building, were drawn by Wilbur Watson and associates of Cleveland.

The arch recently erected is the central one of a series of 13 which will support the sheet-steel roof of the building. Each arch weighs 620 tons complete. The middle one is permanently fastened to its foundations, the remaining ones being mounted on rollers. These rollers, operating on tracks which rest on concrete piling, will permit thermal expansion and contraction of the huge steel mass in every direction. There will be approximately one foot of change in the building length from the lowest probable winter temperature at Akron to the highest summer heat.

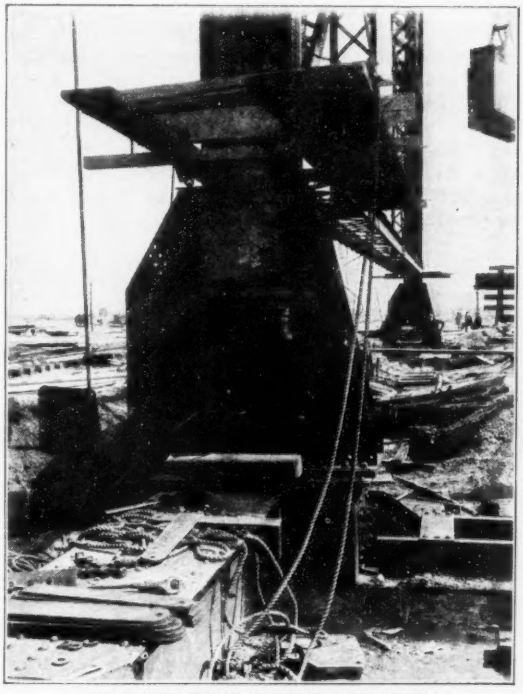
AS soon as the first arch was in place, work was started on the six that will stand to the south of it. It is the plan of engineers to erect the southern half of the factory and dock first, so that assembling of the first of the giant airships can be started at an early date. Construction of the airship and its home will then proceed simultaneously. One new arch will be put up every three weeks.

But erection of the steel arches is not the only bit of difficult work connected with building the world's largest airship shed. Preparation of the ground, for example, was a considerable task.

The building is located on one of the best dirigible landing fields in the country, according to acknowledged experts. The land is nearly level, and is surrounded by a ring of low hills, so that the Zeppelin factory will lie in the center of a huge saucer. This is of importance because such conditions tend to produce even air currents.

The building site is in the midst of a swampy area through which a small stream once ran. This stream was diverted into a large sewer placed beneath the building. In order to bring the building space and the surrounding airship handling area up to grade, the marshy ground was removed—in some places to a depth of more than 2 feet—and solid material was filled in on top of the clay that was underneath. The fill averages 5 feet in depth, and was rolled every 9 inches. Over the eight and one half acres of floor space—an area approximately four city blocks long and one wide—a layer of slag 6 inches deep will be placed, and on top of that a concrete floor reinforced with wire mesh will be laid. This floor must be perfectly level because it will be used as a fixed plane from which to make measurements on the airships to be constructed.

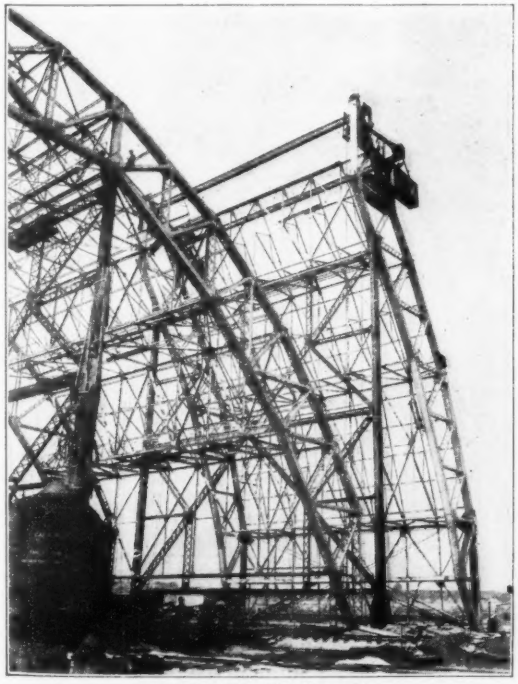
Before work was begun on the factory, it was necessary to lay off a line exactly 1200 feet long, from which all measurements could be made during the course of construction. But since 500 men measuring such a line would each return with a different result, it was necessary to exercise great care in making the measurement. A tested tape was obtained from the United States Bureau of Standards, and was used in establishing the base line. Compensation was made for temperature variations. So accurately was the measurement made that parts of the steel arches, with pre-drilled rivet holes, fitted together exactly, without any trouble.



FOR SPRINGING SIDE MEMBERS

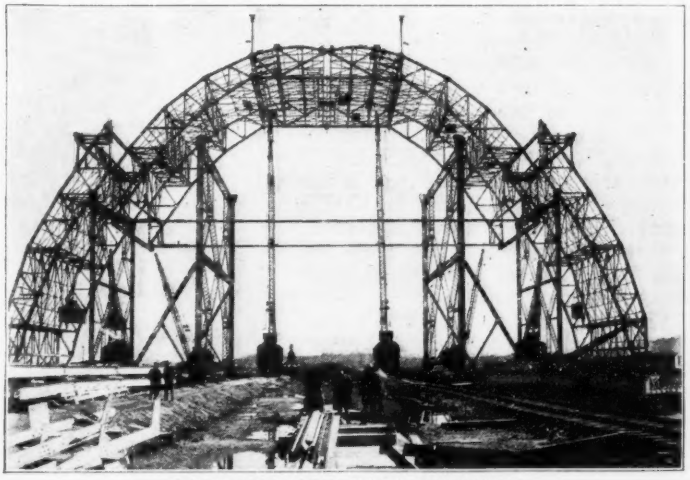
Hydraulic jacks under this falsework spread the tops of side supports so the central span could move into place

Grading of the ground, driving of 1300 concrete piles, and pouring of much of the concrete base for the arches, door tracks, and docking rails was done in the winter, with the temperature below freezing most of the time. By carefully heating the concrete before pouring, then covering it and keeping it above freezing by oil



READY TO BE LIFTED

An arch span assembled on the ground. Falsework—vertical beams—for spreading side members are shown



360 TONS GOES INTO POSITION

Southern side of the hangar's first arch as the central section nears its final position. Falsework for this arch and for the second one may be seen here

fires beneath the covering, none of the material was frozen.

Bedrock is 30 feet below the ground level. The piles, averaging two dozen beneath each arch leg, were driven to this level. In all, 12,000 cubic yards of concrete will be required for the building, and most of this will be below the ground level. A nine-foot concrete tunnel containing electric, water, air, steam, and other lines will run from one end of the building to the other.

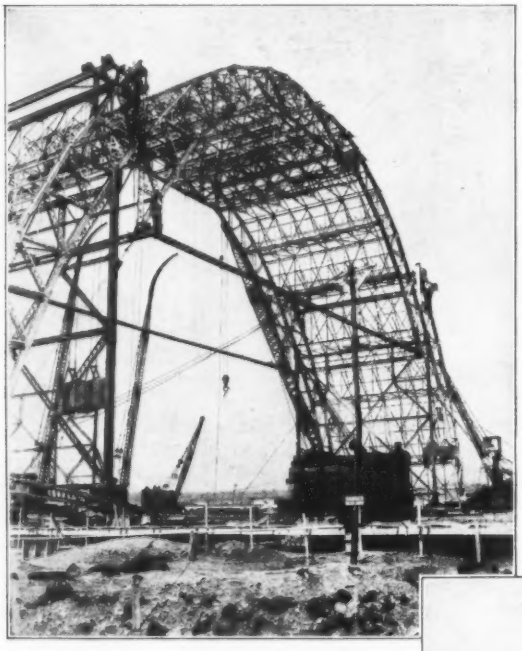
Concrete work for the structure has been pronounced the finest ever used on a major construction job. This is attributed to the great care exercised in pouring and in regulation of temperature while the material set. The concrete masses forming the side foundations are tied together by steel and concrete girders and beams running underground, from side to side of the dock. This bracing will prevent spreading of the foundations under the thrust created by the steel above.

In order to handle airships nearly a fifth of a mile long, a large, unobstructed, level space is required. To obtain this, many acres of land in the vicinity of the building are being brought to grade. For filling, earth from nearby hills is being used, the hills being leveled and the swampy area raised simultaneously.

Visitors to the factory site during the first months of operations have noticed numerous little mounds of earth covering several acres near the building. This is top soil that is being saved for covering the operating area. Turf is considered the best surface on which to handle dirigibles, and grass will not grow readily in excavated soil. Hence the saving of the fertile top layer which will later be spread out.

Extending through the hangar and for 1600 feet beyond each end will be docking rails resting on concrete bases. Over these rails will run cable cars which will serve as mobile anchors for the airships, easing them into and out of the dock.

Such a huge structure as the Zeppelin factory and dock suffers a tremendous stress when subjected to varying wind pressures. In order to minimize this force, the entire building has been designed to present only curved external surfaces. In cross section, the structure is semi-elliptical. For the first 27 feet the walls rise vertically, then begin to curve inward.

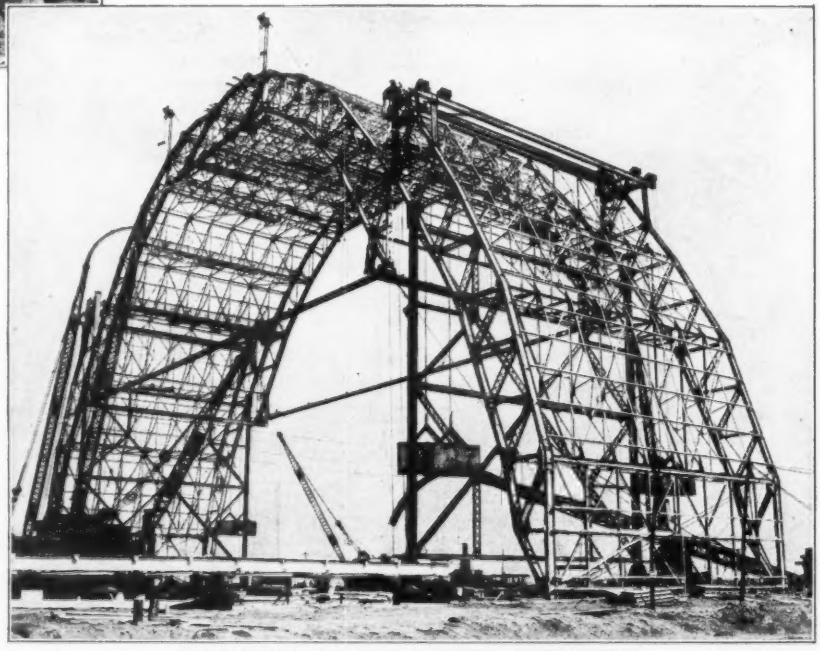


These curved sides are being built to withstand a calculated wind pressure up to 200 pounds per square foot. This is five times the maximum figure for ordinary industrial buildings. Bracing the steel shell to endure such a tremendous stress was not the least of the engineering problems involved. Effective pressure induced by air currents on the outside is reduced by shaping the building so that practically all surfaces are presented to the wind at an angle. But it was found that, when wind of even ordinary velocity blows over the building, there is created a vacuum on the lee side. If the wind speed is high, approaching hurricane proportions, steel plates on the building might be ripped off if they were not properly fastened, or the building might burst from pressure within if the bracing were inadequate. Therefore, the structure was designed so that its members can withstand a stress arising from air pressure both inside and outside.

Doors provided one of the biggest problems. It was necessary to develop a method of opening and closing practically the whole of each end within a short period of time. To accomplish this, "orange peel" doors were designed. As their name indicates, these doors resemble portions of an orange peel, each section representing one eighth of the entire peel.

BASES of the sections rest on electric street-car trucks running on circular tracks. There are 10 trucks for each section, supporting a weight of 1,500,000 pounds, or 750 tons. From the closed to the open position, the trucks travel approximately a quarter of a circle at a speed of 40 feet per minute. Five minutes will be required to open or close the doors at either end of the building.

There are no hinges other than huge steel pins at the apex. Each of these pins is 4 feet long and 17 inches in diameter. All electrical equipment is to be provided by the General Electric Company. Alternating current motors developing 200 horsepower each at 600 revolutions per minute are specified. Gears driven by the motors engage in racks on the outer surface of each door. After such a huge mass of



TWO VIEWS OF THE RAISING OPERATION

Counterweights did most of the work of raising the central arch span. These, the straight arm cranes, and the curved arm cranes which assisted, may be clearly seen in these two illustrations. Below, the span is within 20 feet of the top and counterweights are down

steel has been set in motion, it cannot be stopped without the exertion of a tremendous counter-force. Electro-hydraulic brakes accomplish this.

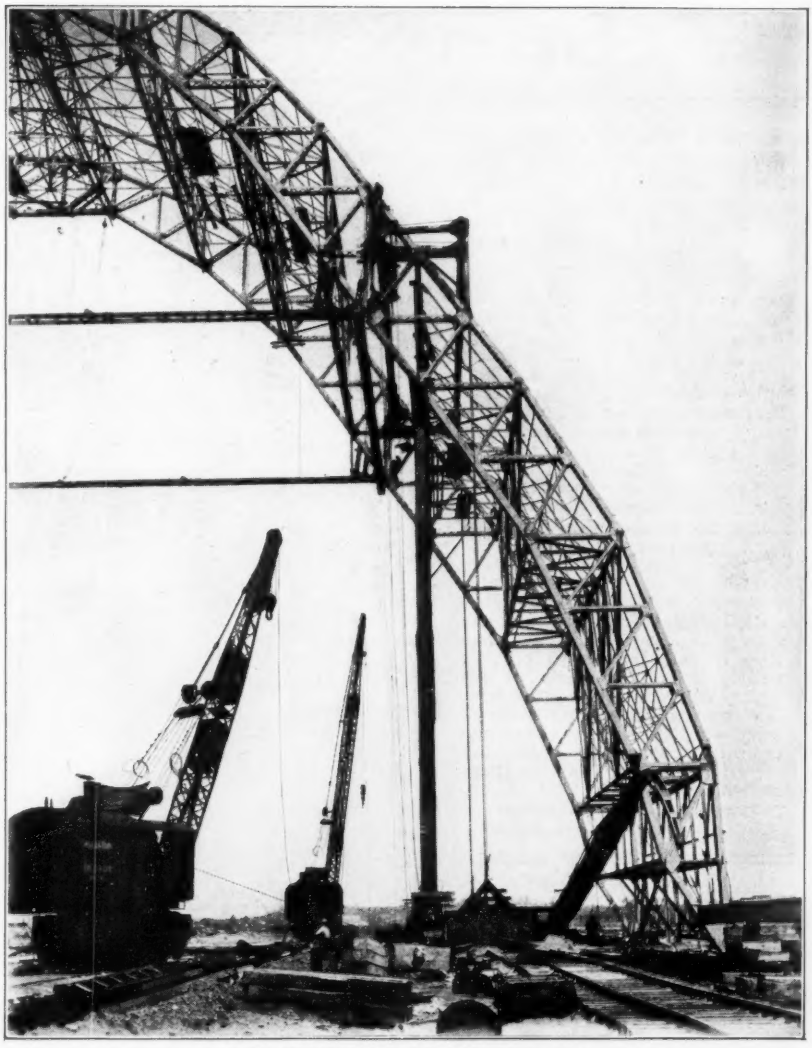
The orange-peel doors are designed so that they will set up a minimum of air disturbance when open, closed, or in intermediate positions. When fully opened, they rest against the sides of the building, producing no greater air disturbance or offering no greater wind resistance than when closed.

The skeleton of the airship factory and dock will be covered with a corrugated sheet steel. Contract for this part of the job has been let to the H. H. Robertson Company of Pittsburgh. However, ordinary corrugated steel common to the building industry for many years will not be used. Instead, a material in which the corrugations are more nearly V-shaped in cross section, instead of the conventional curved form, will be used. In building airship sheds at Scott Field, Illinois, Cardington, England, and Karachi, India, the Robertson Company has developed this special corrugated material.

No paint will be used on the outer surface of the steel plates. Instead, a coating of asphalt and asbestos, covering each individual sheet, will be employed. This protects the metal beneath from all forms of corrosion, and will tend to minimize moisture condensation on the interior of the building by providing for a gradual change in temperature. Such condensation might be detrimental to dirigible fabric.

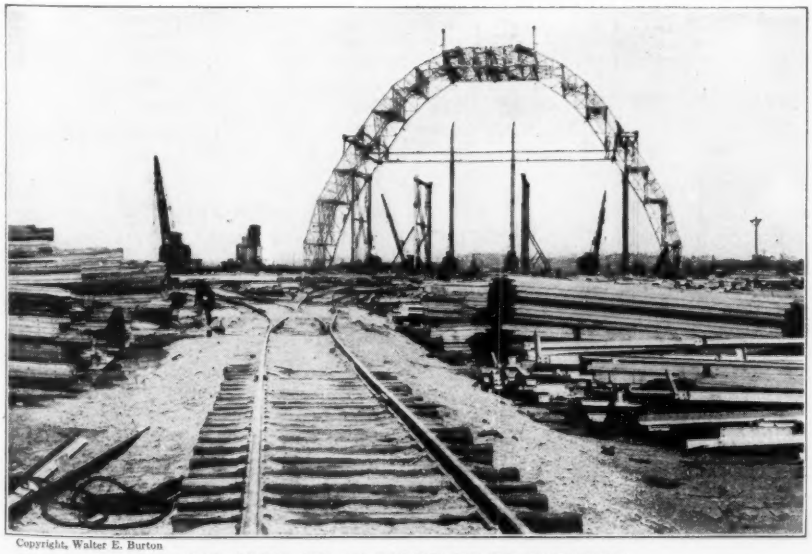
The Zeppelin factory and dock, which has made Akron the center of America's lighter-than-air craft industry, is an excellent example of the frequently-made observation that, when modern science produces a huge machine, it must produce something a little bigger to house it. The building is constructed so that an unobstructed floor area will occupy nearly all of the interior, the remainder being taken up by shops and other rooms on either side. The space is great enough to house an airship of 10,000,000 cubic feet gas capacity—more than twice as large as any now in existence—providing it is built on a six to one ratio of length to breadth. Workmen will reach parts of an airship being built or housed, by means of "cat walks" running from one end of the building to the other, by stairways, and other devices.

The Zeppelin plant is scheduled to be completed sometime in 1930. Construction of parts and testing of materials already have begun at the present Goodyear-Zeppelin plant a mile away. A minimum of perhaps 600 men will be employed for about three years in building the first navy dirigible.



THE ARCH CONNECTION IS MADE

After anxious moments had passed, the first arch was fitted in its place after being raised in the unique manner described here. The counterweight arrangement and the joint are shown



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ONE ARCH UP, 12 MORE TO BE ERECTED

The first arch of the factory-hangar in place. Twelve more will be erected—six on each side. The footings of this one are rigid but the others will be on rollers to take care of expansion

Steam Stages a Come-Back

Question of Steam versus Hydro Generation of Power is Being Answered by Improvements in Steam Power Equipment

By R. M. BOYKIN*

It's Time for Facts

So long and so speciouly have the words "white coal" been conjured with that the man in the street has been deluded into believing the water-power conjurer can continue indefinitely to draw cheap electricity from our water power resources. To the man who simply pays to see the bag of tricks, the conjurer can extract from the hat as many live rabbits as he desires.

It is significant, however, that in the Pacific coast states the trend is toward steam generation although in that region there is sufficient undeveloped water power to supply the region's electricity demand for many decades to come. Why? Because, as Edison recently said, electrical power can now be generated cheaper by steam than by water power.

In industrialized America, the man who pays the bill, the man who is called upon to elect a politician on the basis of his white coal development promises, and the investor, large or small—all are vitally concerned in this probem of generating electrical power. It's time they should have facts. The accompanying article gives them.

—*The Editor*

ALMOST any morning of the year from November first to All Fools' Day, the visitor to the Pacific coast can see monstrous banks of fog sweeping in from the ocean, covering the land like a soggy blanket. Westerly winds carry this murky mass of ocean moisture to the cold peaks of the Cascades and Sirerras where it is precipitated as rain or snow. Down the mountain sides the water hurtles, over precipices, through canyons, and back to the ocean in endless grandeur.

Contemplation of this cycle is inspiring, indeed, to the lovers of Nature's beauties, but it is also hailed as a source of great wealth by practical men who visualize the harnessing of this stupendous amount of water power to serve the needs of man. A travesty it is that this gift of Nature should become a political football for demagogues. Those who aspire to preserve the beauty of this unperishable resource will soon have nothing to fear; power companies, with almost half the undeveloped water power of the nation at their very elbows, are turning to their first love, the steam generator, and so-called nature conservationists may learn that, like many a woman, their pet protégé possesses little more than the fatal gift of beauty!

But what about the failure to utilize the millions of horsepower in undeveloped water power sites of this country? What about exhausting the diminishing supply of fuel? Here the rabid conservationist is given another bone to chew!

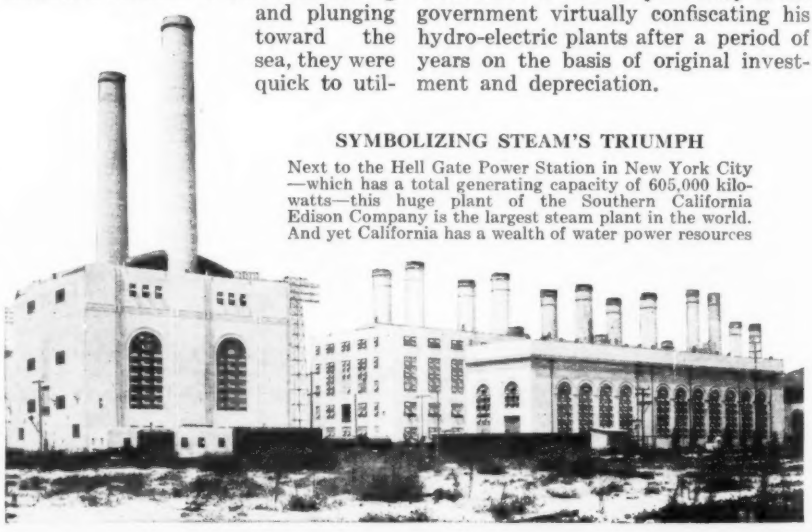
There is an indefinable romance and lure in the magnificant rush of a giant river over a wall of rock. "Endless 'white coal' that may be had for the taking," is the popular illusion. What a wonderful wealth of cheap power! Whether it be the gracefulness of Multnomah, or the grandeur of Niagara that appeals to the senses, there is ever-present the thought of "power" and the reflection on the wastefulness of its energy. And this conception is not altogether ill-founded.

IN theory, at least, all our power sites should be harnessed before our more perishable resources—such as wood, coal, or fuel oil—are used. But practically the problem is not so simple, and that is a factor that the conservationist has overlooked. It begins to appear as though his eternal vigilance of this treasure chest of Nature has been unnecessary, for the inventive genius of the engineer has brought the steam plant back into the picture as a formidable competitor of the hydro-electric plant in the production of electricity, and the guardians of "white coal" may find themselves holding an empty sack!

When the miners of '49 found the mountain streams of California diving and plunging toward the sea, they were quick to utilize the power at hand. Giant nozzles were used to tear down the gold bearing gravels of the valleys, and it was but a single step to put the high pressure jet to useful work against a series of buckets attached to a wheel. This wheel at first was belted to various types of mechanical equipment, but later was directly connected to the first crude type of electric generator, and with the success of this contrivance, the engineering world saw the birth of the hydro-electric industry. Today, the 559 hydro-electric plants near the western border of this country have reached almost the acme of mechanical perfection.

As might be expected, there were some abuses in the early stages of development. Then came federal and state regulation, culminating in the passage of the Federal Water Power Act in 1920. The intent of this regulation may be praiseworthy, and certainly many aspects of it are beyond reproach, but there are many drastic provisions that promote a miserly hoarding of resources. Why this tying up in a napkin the gift bestowed on us so bountifully by Nature? Why encourage the burning of diminishing fuel, while the endless cycle of power in rain and rivers may soon go begging for bidders?

FOR example, the recapture clause of the Federal Water Power Act alone is sufficient to throw a scare into the hard-headed business executive. He is loath to face the possibility of the government virtually confiscating his hydro-electric plants after a period of years on the basis of original investment and depreciation.



SYMBOLIZING STEAM'S TRIUMPH

Next to the Hell Gate Power Station in New York City —which has a total generating capacity of 605,000 kilowatts—this huge plant of the Southern California Edison Company is the largest steam plant in the world. And yet California has a wealth of water power resources

*See "Among Our Contributors," page 197.

And the issue is a vital one. Of the 55,000,000 horsepower available in the streams and rivers of the United States, only about 12,000,000 horsepower has been developed for the production of electricity. And the use of electricity in homes and in industry is increasing by leaps and bounds. In our company, alone, the demand for "juice" for homes has increased from 401 kilowatt-hours to 763 kilowatt-hours since 1922. During the last decade the use of electricity throughout the nation has practically doubled. To this fact may be credited much of our national efficiency and prosperity. The comfort of almost every little home and hamlet has been enhanced by electric light and electrical labor-saving appliances.

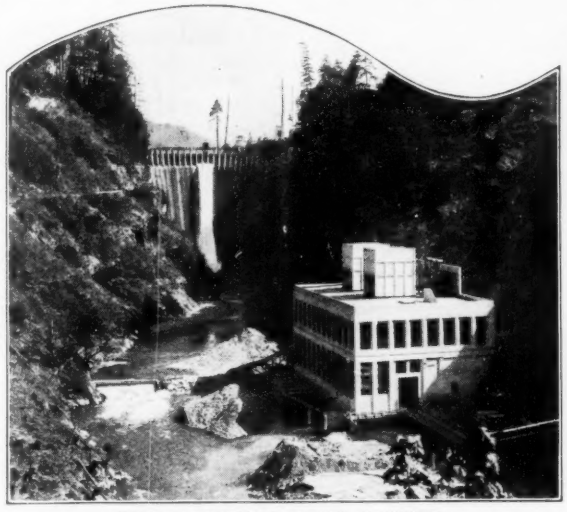
If 30,000,000 horsepower were to be generated by steam instead of water, the consumption of coal in modern stations operating on a 50 percent load factor, would be a hundred million tons per annum. At an average cost of four dollars a ton at the boiler, the annual loss from burning coal and wasting water would be 400,000,000 dollars.

BUT the hand-writing on the wall may be read. With unprecedented wealth of water power at our very door, the power companies of the Pacific slope are definitely turning to steam as a source of electric light and power. Our company, the Puget Sound Power and Light Company, is just beginning the construction of a 5,000,000-dollar steam plant on Lake Washington, which will eventually generate as much electricity as is now produced by its hydro-electric stations. In Southern California, the Edison company, alone, has put in service over 400,000 horsepower of steam plants since 1924. At the present time this company has 588,000 horsepower of hydro-electric plants but when the new unit is completed in 1929, it will have 550,000 horsepower of steam with no increase in water power.

The Great Western Power Company of California is at present installing some 50,000 horsepower in steam, making a total of 92,000 horsepower of steam for this company. About 50 percent of the horsepower developed by the San Joaquin Light & Power company is from steam, and almost the same percentage holds good with the Pacific Gas & Electric Company.

And this in an area normally considered to be a hydro-electric stronghold! But bare facts are tedious, although surely they accent the fact that steam has come to stay and to compete upon an equal, or even a favored, footing against water power!

Hydro-electric developments are never a matter of easy exploitation. Aside from the barriers of legal restrictions and regulation which are difficult enough to hurdle, many are the added problems to solve. The excessive values that some individuals have placed on undeveloped water power sites, the difficulty of power companies to purchase such public lands, demands for imaginary damages to lands used for power purposes, and many other similar obstacles must be taken into consideration on every proposed hydro plant. Aside from these difficulties, long periods of time must elapse in order to make proper studies of stream flow and, because of the seasonal and annual variations, it is extremely necessary to take flow records over several years. The value of a hydro-electric plant depends largely on the amount of water available and this must be pre-determined carefully, before a proper analysis can be made. Then, too, geological and topographical conditions must be carefully studied; and when a definite conclusion is reached, the power demand may not be suited to the plant proposed.



THE ORIGINAL COST COUNTS

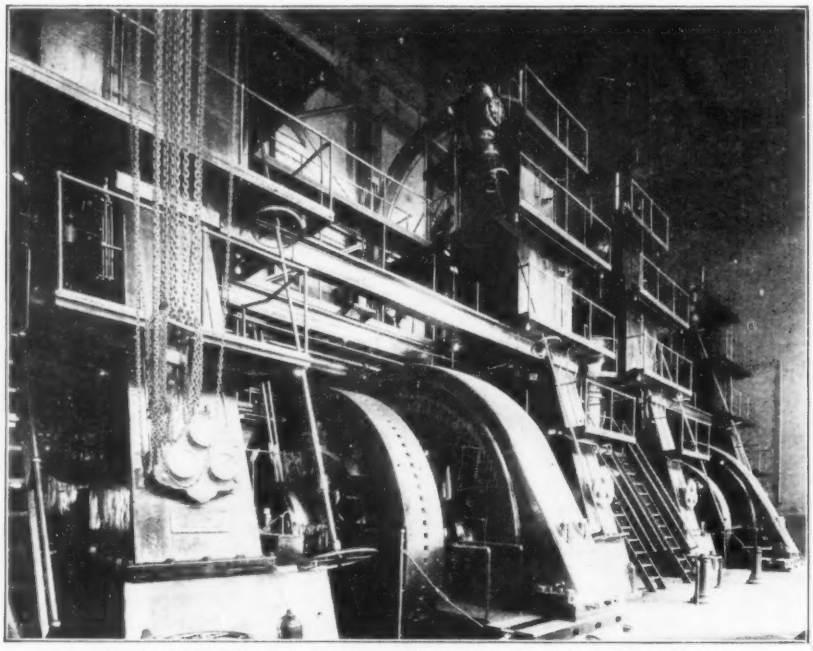
The Baker River plant, Puget Sound Power and Light Company, cost 7,000,000 dollars and was three years in building

THERE are likewise other difficulties confronting the engineers who must plan the construction of a hydro plant. The construction period is usually two or three times as long as that for the steam plant. Where a hundred thousand horsepower steam plant can be designed and put in operation in less than a year, a similar hydro plant might take from two to three years, depending upon its complexity. If long rock tunnels, high dams, difficult foundations and inaccessible country are involved—which is usually the case—the problems take months to solve. This ties up capital for a long time without return. Furthermore, the original investment in a hydro plant is several times that of a steam plant of equal capacity. If the hydro cost per horsepower is more than a predetermined amount, the interest on the indebtedness may well be more than the cost of operating a steam plant, including fixed charges, fuel, and labor.

Then consider the stupendous cost of long transmission of high voltage current from the mountain recesses to centers of population, wider right-of-way, and costly transformation and distribution of the hydro-electric output. Furthermore, the initial construction of a hydro plant, such as the dam, water tunnel, and so on, representing by far the greatest investment, must be completed at once regardless of whether or not the entire power available is needed. Unlike a steam plant, this part of the hydro plant cannot be built in units, as needed, and therefore the investment is often far out of proportion to the available market for the electricity produced.

THE steam plant is a mere child's toy by comparison. In the first place it involves no cumbersome regulation. Any location with rail or water transportation, near the center of population, and close to a water supply for condenser purposes, will usually make the site easy to find. A plant whose storage reservoir is a coal pile does not have to fear a lack of rainfall during the summer months. The steam plant is usually located at a point close to the load center, and this greatly simplifies transmission line problems. Because of the short distance that power must be transmitted, low voltage can be used, and this fact again simplifies switching and transformation.

But the real crux in the come-back of steam in the generation of electric energy is the vast improvement in equipment of the steam plant. Although there has been few marked changes in the hydro-electric plant during the last 20 years, the modern steam plant of today is as different from that of a few years ago as day is from night. A station operated by the Edison Electric Illuminating Company of Boston produces energy for less than a pound of coal per kilowatt-hour. Another station in the same city, built by the same firm 10 years earlier proudly boasted a record of 1.75 pounds of coal per kilowatt-hour. The U. S. Geological Survey reports that the national average since 1919 has been reduced from 3.20 pounds per kilowatt-hour to 1.83 pounds per



TWO OLD TIMERS THAT GENERATE 3500 HORSEPOWER

These reciprocating steam engine generator units, owned by the Puget Sound Power and Light Company, are so bulky that they occupy as much space as a 100,000-horsepower turbine

kilowatt hour—a remarkable showing in just a few years! The conservation of the nation's coal through increased thermal efficiency in electric light and power plants, as compared with 1919, is 5 percent of all coal used each year in the United States.

At the time the hydro-electric plant reached its present high state of efficiency, the steam engine was still of the cumbersome reciprocating type, with huge cylinders and pistons. The machines were ponderous and slow moving, and occupied an extensive floor area. Boilers were small in size and stoked by hand, of low pressure, and with practically no super-heat. Electric generators were belted to the engine, and the result of all this was that efficiency was low and power cost high.

CONSEQUENTLY the super-power age of today was mothered by hydro-electric plants, rather than by steam. But the tide is turning to steam power. There came a time when an engineering genius discovered that a jet of steam could be used just as well to play on a wheel blade as could the giant water nozzles of the hydraulic mining days of California, and the steam turbine became a reality. By substituting rotating for reciprocating elements, it became possible to use higher steam pressures, greater speeds, and therefore smaller units to produce more power. From that time on, the development of the steam turbine has been rapid until it has now reached a point where the water turbine must look to its laurels.

The steam boiler of today seems to have limitless possibilities. One of the largest in the world today, that in the Edison company plant at Long Beach, California, stands 65 feet high, the equivalent of a five-story building.

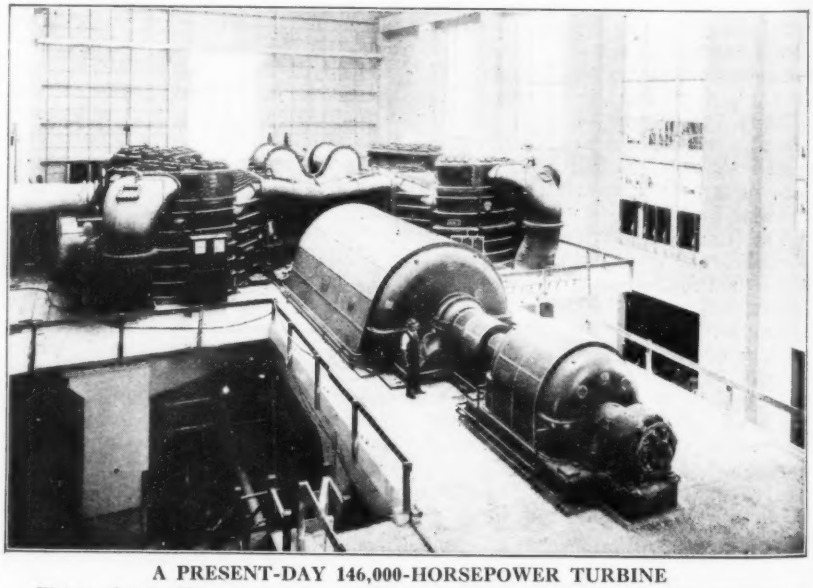
There are very definite limits to the ability of water power to compete with steam power in the present state of the art, notwithstanding the fact that our huge water-power systems have almost reached the acme of perfection so far as efficiency is concerned, and super-power steam stations are approaching that point. For that reason, steam stations are increasing in size and output at a greater rate than hydro-electric stations, and unless many water-power sites are developed at once, they may not be developed for many years to come, if at all—at least not until there is a fuel famine. And according to authorities, among them the United States Geological Survey, there is in sight at present enough coal to last many hundreds of years.

Yet, there is a persistent popular notion, fostered by unreasoning demagogues, that any waterfall can be converted hydro-electrically into a never-ending stream of gold. Too late, perhaps, they will learn that all is not gold that glitters, not even the sparkling spray of a Niagara, the scintillating orations about Muscle Shoals, or the visionary Utopia of Boulder Dam.

Moved solely by the pressure of economic forces, it is significant that in the decade from 1920 to 1930 it is estimated that the increase in water power will total only 5,960,000 horsepower, whereas steam during the same period, will show a total increase of 13,225,000 horsepower.

JUST the saving of a few more heat units, a few more refinements in the turbine—and both of these are already in sight—and the cost of steam-generated power with the present price of fuel, will be less than that generated by hydro. Today the two plants are practically equal and only the highest technical skill can determine which of the two would be the more economical for any given condition.

Under proper encouragement and sympathetic regulation by the state and nation it should be possible to continue to develop our power streams for some years but, from this time forward, the developments will be carefully planned.



A PRESENT-DAY 146,000-HORSEPOWER TURBINE

Weight of units 25 years ago was at the rate of 32 or more tons to each 1000 kilowatts capacity. Modern generator units weigh less than nine tons per 1000 kilowatts capacity

Designing Large Telescopes

A Suggestion of the High Engineering Refinement Involved in This Highly Specialized Problem

By J. W. FECKER
Optical Engineer

TO-DAY'S telescope, perfectly balanced and as nearly perfect as may be, represents the outcome of a series of problems in engineering which, before a single piece of material is actually worked, the engineer studies out, prepares, and modifies, until perfection of design is reached by means of the application of related sciences such as mathematics, optics, electricity, metallurgy and foundry practice, and mechanics. Thus the finished product functions from the start. It comes also within the required limits of tolerance, which are very rigid.

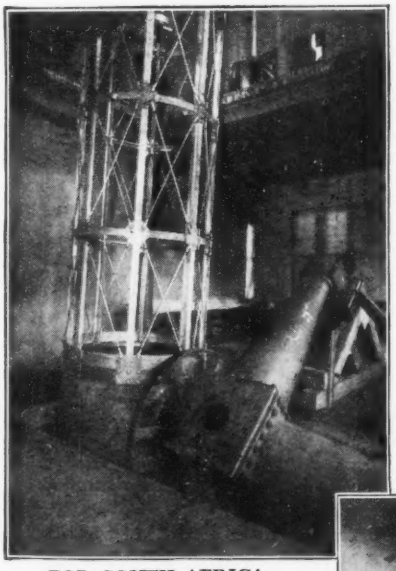
Some idea of the main problems involved in creating such a telescope may here be given. The goal sought is to obtain a mechanical mounting to hold the optical parts in a fixed and unvariable alignment, so that the whole unit may be pointed readily to any part of the sky, and any desired motion maintained without interruption due to irregular driving or shifting of any part.

When the design is completed, the remainder of the problem rests with the working staff. Its members should be, and for the construction of the 60-inch telescope illustrated in these pages actually are, highly skilled mature men of long experience; men with character and balanced temperament, each doing his portion of the work, under adequate supervision, with extreme skill. To these and other faithful workers of the same sort everywhere a word of praise for their efforts is due.

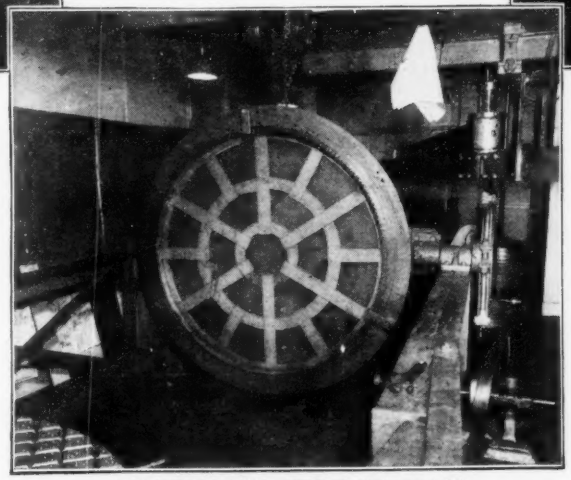
Turning now to the materials: The optical system of a large telescope is made up of a number of lenses or mirrors, or a combination of both. The material for the lenses and mirrors must be most carefully tested for uniformity of annealing and, in the case of lenses, for uniformity of index of refraction. Following these preliminary tests the curves of the glass are mathematically computed and the lenses ground, polished, and centered. In this stage they are about 25 per-cent complete, and have yet to be figured. This is the final and most difficult part of the optical work. As a rule the tests before final polishing will show aberrations. These are corrected, and the surface curves are perfected by means of small hand-polishers—entirely a matter of skill and experience on the part of the person doing it, no mechanical contrivance being yet known.

The errors to be eliminated in the final hand polishing

THE author of the accompanying article is a foremost professional designer and builder of large telescopes. With his father, the late G. L. Fecker, he was for many years engaged in much the same work for the famous firm of Warner and Swasey of Cleveland. During this period were built the mounting for the 72-inch reflector of the Dominion Astrophysical Observatory, Canada; a 36-inch reflector for the University of Arizona; and a 60-inch reflector for the Argentine National Observatory. The 60-inch reflector for the Ohio Wesleyan University was designed by the author at the time mentioned and the disk for its mirror, cast at the Bureau of Standards last year, is now in his shops at Pittburgh being prepared. Recently he made a 30-inch reflector for an amateur, Mr. H. C. Gibson, of Philadelphia, and a 24-inch photographic refractor for Harvard. The present article was written around the new 60-inch reflector for Harvard's new South African observatory, being finished at the present time in the Fecker shops. Mr. Fecker is the successor to the noted John A. Brashear.—*The Editor.*



FOR SOUTH AFRICA
The new 60-inch reflector designed and constructed for the large Harvard South African observatory near Bloemfontein



THE FIVE-FOOT DISK OF GLASS
In the polishing machine, but temporarily tipped up for testing. Note spiderweb supports visible through glass; also the polishing lap visible in the lower corner

UPPER END OF TUBE
Showing adapters to hold accessories and the cell of the diagonal Newtonian secondary mirror at the center of the tube

are so extremely minute that the usual changes of temperature in a room would introduce errors 10 or 20 times as large. Therefore a "constant temperature" room is an important aid. In it the glass is allowed to stand many hours after each working, in order that a reliable test may be obtained. When it is realized that merely placing the warm hand on a large glass optical surface for a few seconds will cause enough local expansion at that area to be visible to the delicate test four hours afterward, an idea may be had of the accuracy required in working such optical surfaces.

A good reflector mirror is made to an accuracy of better than one tenth of a wavelength of sodium light, or better than one 500,000th of an inch. With very long focus lenses or mirrors the accuracy required is very much greater; and it increases with increased sizes. There is also the problem of a lens or mirror bending due to its own weight. In every large piece of glass a measurable bending, even when the thickness is as great as one sixth the diameter, is inevitable. In the 60-inch Harvard telescope just completed, the mirror was successfully supported and worked in such a way as to overcome this bending when in use, notwithstanding that the glass disk is not as thick as one-sixth the diameter. The differential expansion of the glass and the cell in which it is placed must be guarded against, where temperature ranges are present, between the 100 degrees or more of a midsummer day and 20 or 25 degrees below zero of midwinter.

SEF

LARGE BALL BEARINGS

For polar and declination axes of the 60-inch reflector. For scale of size note watch against the largest bearing

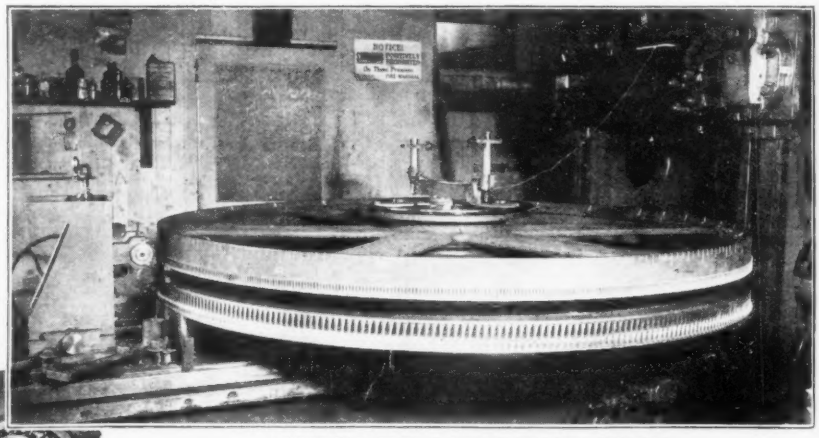
AS the sizes of telescopes have constantly increased, the photographic telescope has rapidly come to the foreground, particularly the photographic reflector. There are two reasons for this. First, by the use of photographic plates and long exposures it is possible to record details accurately which the human eye could not see, even with the largest of telescopes. As the photographic plates are handled by a skilled observer, he is able to expose and record faster than observations could be made by visual means. Measuring the plates can readily be done by members of the observatory staff, giving the astronomer more time for the development of new theories from the plates. Second, since the disk required for the objective lens of telescopes becomes more difficult for the glassmaker to produce, in proportion to its increase in size, the cost of the raw disks for refractors becomes practically prohibitive; whereas, for the disk of the reflecting telescope the only requirement is uniformity in annealing. There is no effect on the image of the reflector because of variation of index of reflection, fine striae or bubbles in the glass. Again, the reflector involves a purely front surface refraction; there is therefore only one surface requiring optical figuring on each element.

For these reasons, among others, a photographic reflector can be made about four times as large as a photographic refractor for the same financial outlay. Probably this is why work among skilful amateurs in making reflectors has been going forward with such an interesting and lively impetus.

In the mechanical mounting, the axes and tube are computed for minimum deflection. In designing the optical system through calculation, the maximum misalignment which can be tolerated without affecting the image, is determined. This is usually of the nature of five to ten seconds of arc, but may be less, depending on the type of instrument. The tube is designed to have a maximum deflection not to exceed 80 percent of the tolerance. Actually, in the tube of the 60-inch Harvard reflector this tolerance is 0.0096 inch in a length of 19 feet 4 inches; the diameter of the tube being five feet nine inches. This small deflection is obtained by the use of heat-treated duralumin tees, angles and tie rods; also duralumin in all parts of the support mechanism.

The optical parts weigh approximately 2000 pounds, and the tube about five and a quarter tons, making the total weight of tube with optical parts six and a quarter tons—all perfectly balanced about the declination axis.

Axes sufficiently heavy to carry such a weight with minimum deflection, weigh another six and a half tons. The driving worm wheels and circles, and declination sleeve, bearings, and worm wheel housing, add another five tons. This is comparatively not a very large telescope, but the figures stated may give some idea of the weights which must be moved with absolute accuracy and control.



CUTTING THE 8-FOOT WORM WHEEL

The tolerance permitted is only 1/25,000 of an inch. Any mechanical engineer or skilled mechanic knows what that means in the way of super-refinement

IN moving such weights in astronomical engineering, two problems present themselves. First, to move this mass of metal and glass at an absolutely uniform rate, exactly at the speed of the earth's rotation; second, to start and stop such a mass without jar, vibration, or surge, so that the most accurate setting can be made with certainty every time. The solution of the first problem lies in the proper choice of bearings and accuracy in the driving mechanism.

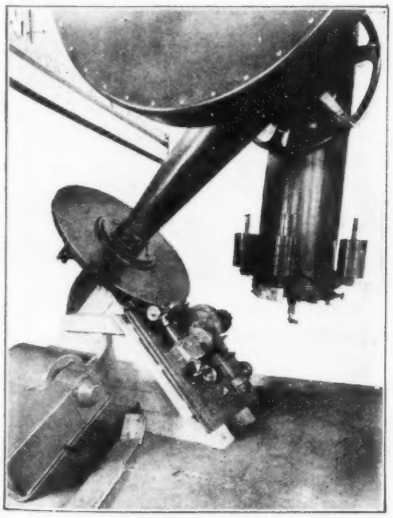
In practically all the large modern mountings, self-aligning ball bearings are used throughout on the axes for both radial and thrust bearings. A ball bearing is more sensitive in its operation than a roller bearing of equal size. Self-aligning ball bearings are used in order to allow movement of the upper or lower end of the axes, thus placing the polar axis exactly parallel with the earth's axis. These bearings are enclosed in oil-tight and dust-tight housings. Thus there is no exposure and practically no wear over an indefinite period of time.

The driving mechanism may be either by properly synchronized electric motor, or by a pendulum-regulated weight-driven clock. Either

drive may be operated by means of a final worm driving a worm wheel held fast to the polar axis. In large telescopes the main worm wheel is usually between seven and nine feet or more in diameter and has 720 teeth cut in its bronze rim. The driving shafts, gears, worms, and worm wheel must be free from any errors of eccentricity or spacing of the teeth. Where there are several gears and shafts in the clock and worm drive, there is a possibility of a periodic building up and neutralizing of all the minute errors, producing a periodic driving error in the telescope. This would be very detrimental to the observer's "astronomical" well-being and to the results obtained.

In large photographic telescopes, in the Cassegrain combination, equivalent focal lengths as long as 100 feet are frequently employed, and a drift of the star image from the cross wire of as much as one thousandth of an inch can readily be detected. Figuring back, then—one one-thousandth of an inch deviation in 100 feet radius is produced by one twenty-five thousandth of an inch error at a radius of four feet. This is therefore the maximum error that can be tolerated in a worm wheel eight feet in diameter. Thus the maximum allowable error in driving, when measured at the 100-foot focus, does not exceed one one-thousandth of an inch. This error must represent the sum of all possible errors in the entire driving mechanism.

Naturally, when the size of the telescope is materially increased, the standards of accuracy must be correspondingly increased, so that there will be no visible driving error. Such a driving worm wheel is usually cut by mounting on it an accurately divided silvered circle upon which the settings are read by means of two micrometer microscopes. The worm wheel with the circle is moved for each tooth, and is indexed through the two microscopes. "Cutting around" is done and measured several times, and after the final cutting the wheel is ready for lapping and correction of the spacing of the teeth. A final check by optical methods makes possible an accurate check of the worm and worm wheel before the instrument is tested on the stars.



AN ELECTRIC DRIVE

Lower end of 24-inch Harvard refractor, showing quick and slow motion gearing and electric drive, also dust-tight cover

Next for consideration comes the problem of providing for setting the telescope accurately on a star or other object. To move with precision a mass of 18 tons, so as exactly to bisect a star image with a cross wire of spider silk only about one ten-thousandth of an inch in diameter, calls for a nice balance of all forces. Thus the telescope must be perfectly balanced in all positions; the bearings must be very sensitive and properly proportioned so that there will be no sluggishness. The driving parts must be free from lost motion, spring, or deflection. Any departure would mean that the image could not be moved a desired fraction of a thousandth of an inch without moving it too much or too little.

THE story does not, however, end here. The accuracy must be maintained almost indefinitely. Exposed as a telescope is to heat, cold, dust, sweating, and freezing, it must be made so as to eliminate as far as possible the effects of these deteriorating agents; also to require the smallest possible outlay of effort and expense on upkeep and care. In other words, it must be "neglect-proof," as far as this may be accomplished. Compared with the size of his task, the astronomer's life is not a long one—and on winter nights not a merry one. Hence, any point of design that lends itself to releasing the observer from inconvenience in operating an instrument, or spending valuable time on its care and upkeep, can not help being a welcome aid in the progress of research. All gear drives, then, operate in oil baths within oil-proof and dust-proof cases, and the entire assembly of a drive unit is located under a dust-tight cover which can readily be removed if necessary.

The fact, also, that the observer's work is done the greater portion of the time in the dark, has led to the development of the simplest means of operating the controls—that is, electrically wherever possible. A light portable switch box with push buttons, on a six-volt circuit, operating relays and dynamic breaking controllers for the motors, is usually used. The box has either four or six push buttons, the four-button type giving slow motions, forward or reverse in right ascension and declination. The two extra buttons give quick motions. The motions are all electrically interlocked so that two speeds can not be engaged at once. The wiring is led by means of cables from the observing station, through the hollow axes and to the main switchboard, generally on the observatory wall. This switchboard is frequently quite complex for, in addition to the telescope motions and electrically operated clutches, many wires are brought to the observing point for such accessories as spectrographs, micrometers, guiding eyepieces with illuminated crosswires, and so on.

TWO-FOOT REFRACTOR

A 24-inch photographic refractor designed and constructed for Harvard University Observatory at Bloemfontein, S. Africa

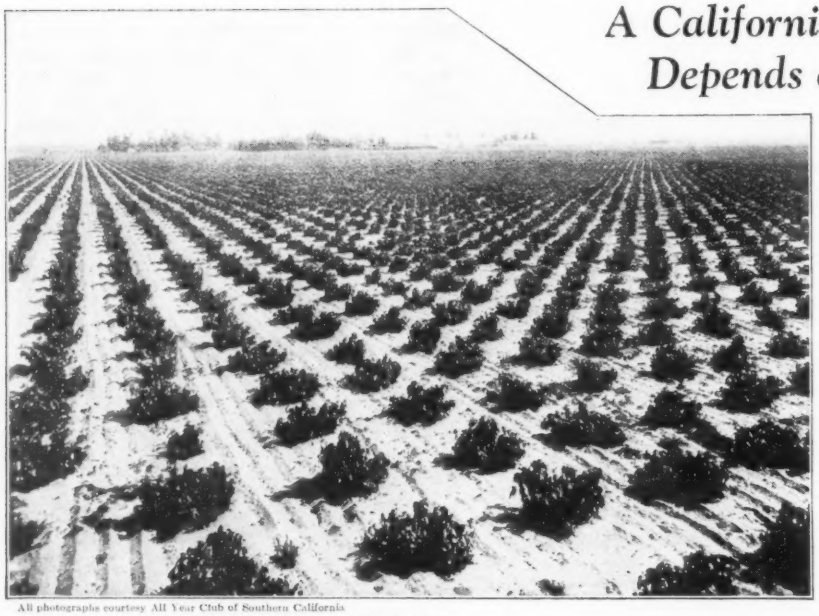
The many accessories, such as spectrographs of various types and sizes, interferometers, photometers, plate-holders, and micrometers, to say nothing of the observing platforms and domes, each has its own peculiar set of problems, which must be intimately known to the designer and carefully studied before a successful design can be arrived at. Each new instrument is different from the preceding one, built for a special program of scientific work, yet each must work the first time—and will, if designed with the precision and care which has been explained.

The newest telescopes, although more complicated mechanisms than those of a generation ago, are simple to operate and care for, and are also considered pleasing to look upon. They have the highest degree of accuracy yet attainable by available scientific and engineering methods.

With continued unselfish co-operation on the part of the astronomer we anticipate further achievement in this peculiar brand of engineering—designing and creating immense, massive instruments having the refinement and rigidity of the smaller ones.

World's Largest Vineyard Uses

A California Community of Over Depends on Grape By-Products



All photographs courtesy All Year Club of Southern California

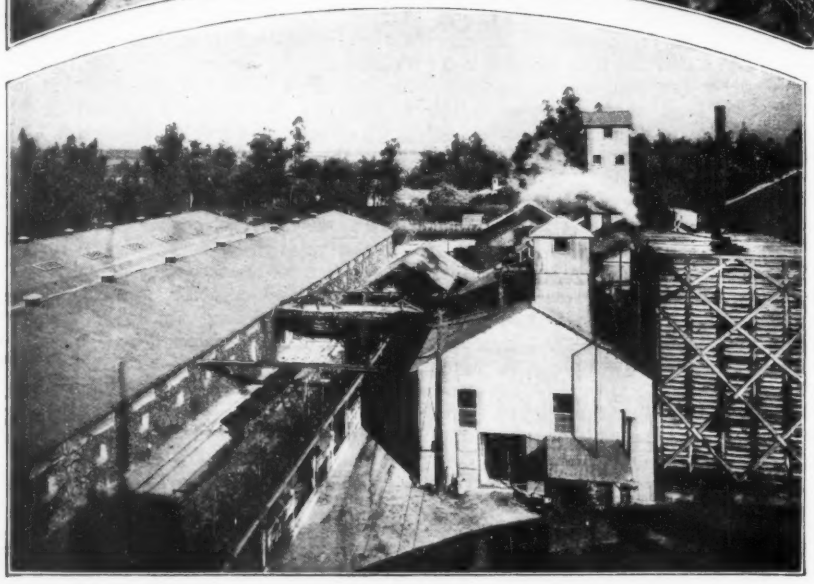
A DESERT VINEYARD

A sweeping view of a desert vineyard at the foot of the Cucamonga mountains in Southern California where over five hundred varieties of grapes are grown. The soil is of sandy decomposed granite, giving the fruit a very fine boquet. Irrigation is from wells

AT Guasti, California, is perhaps one of the most unusual communities of the state. Here is a town devoted to a single industry, its 2500 inhabitants all working for the company that owns and operates the industry. This tract of land was originally a desert, but is now a mammoth vineyard, in which over 500 different varieties of grapes are grown, seventeen of which are produced in commercial quantities. Twenty thousand tons of the juicy fruit are ripened here each season. Half the product is shipped out as fresh fruit for the markets from coast to coast; the other half is made into grape by-products in an enormous plant with the most modern equipment. These by-products consist of such wines as are legal, medicinal tonics, and cooking sauces.

GATHERING THE GRAPES

At left above, and above: Picking Alicante Bouschet deep red grapes in the vineyards of Guasti, California. The vines usually bear approximately 100 pounds of fruit; the fruit from a single vine is sufficient to fill three or four boxes—each box containing from 24 to 26 pounds of luscious grapes

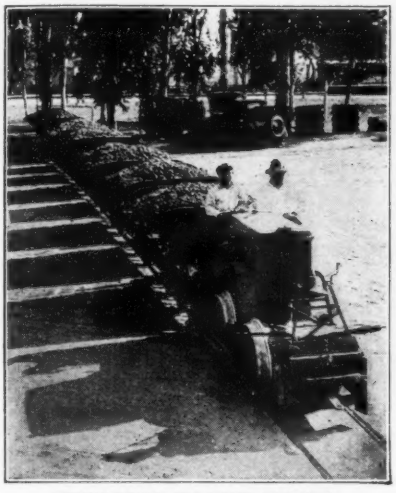


SCIENCE ASSISTS NATURE

In the left center is the dumping platform for loading grapes on the conveyor belt to feed the crusher shown in the center of the picture. The fermentation house is to the left and power plants to the right

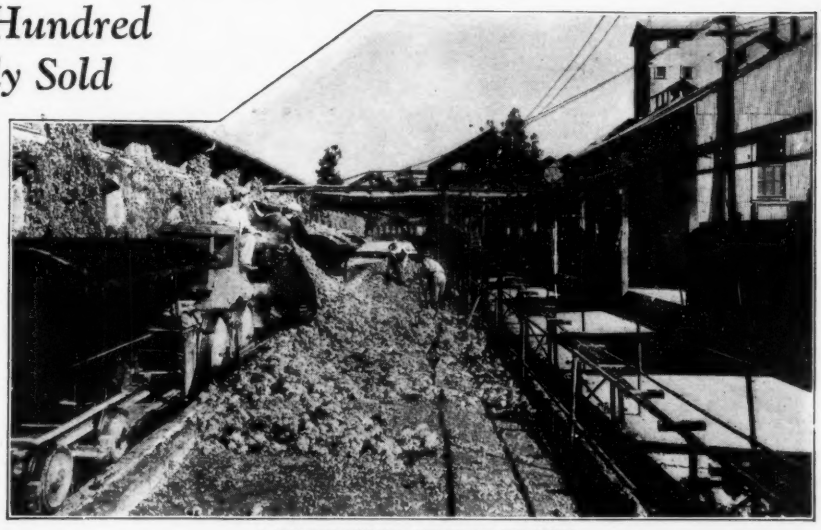
Machinery and Chemical Control

Two Thousand Five Hundred Which Can Be Legally Sold



BRINGING IN THE FRUIT

Cars holding one and one half tons run over 22 miles of railroad carrying the fruit from the fields to the huge crushers

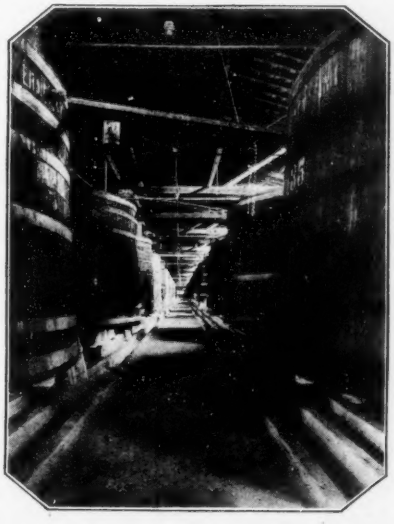


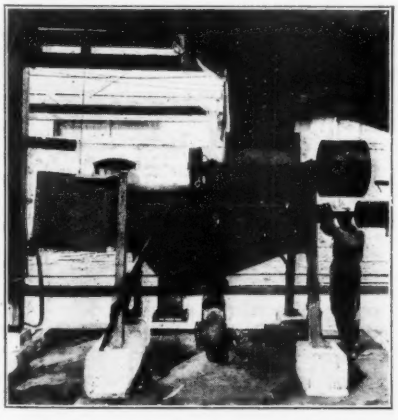
A BUSY TIME AT THE PLANT

The cars bring in the grapes from all over the 5000 acres of vineyards. They are dumped at the plant and shovelled on to a conveyor belt which carries the grapes to the crusher

NATURE WILL FERMENT! ➤

The fermenting house contains 200 five thousand gallon tanks. It is possible to ferment 1,000,000 gallons of juice at a time





➤ **THE MIGHTY CRUSHER**

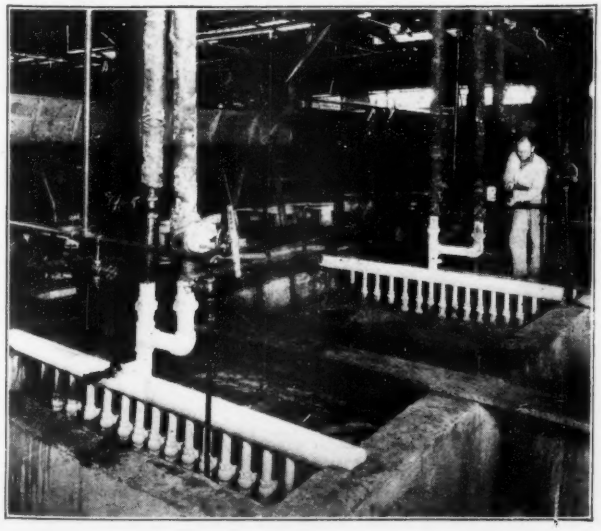
The crusher has a capacity of 40 tons an hour. It stems and crushes the fruit. The stems are afterwards used as fertilizer

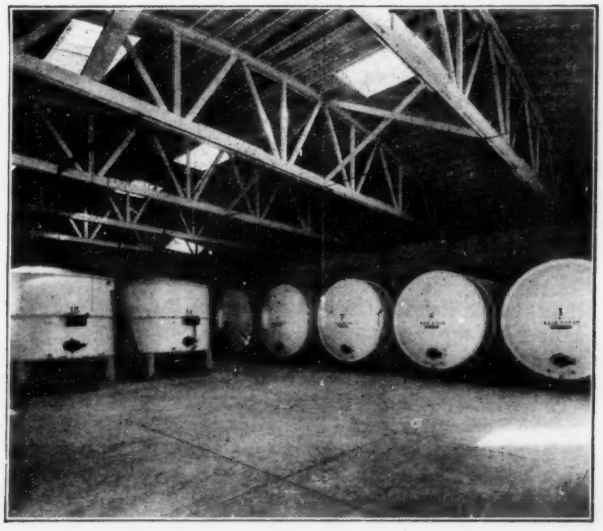
REFRIGERATING THE JUICE

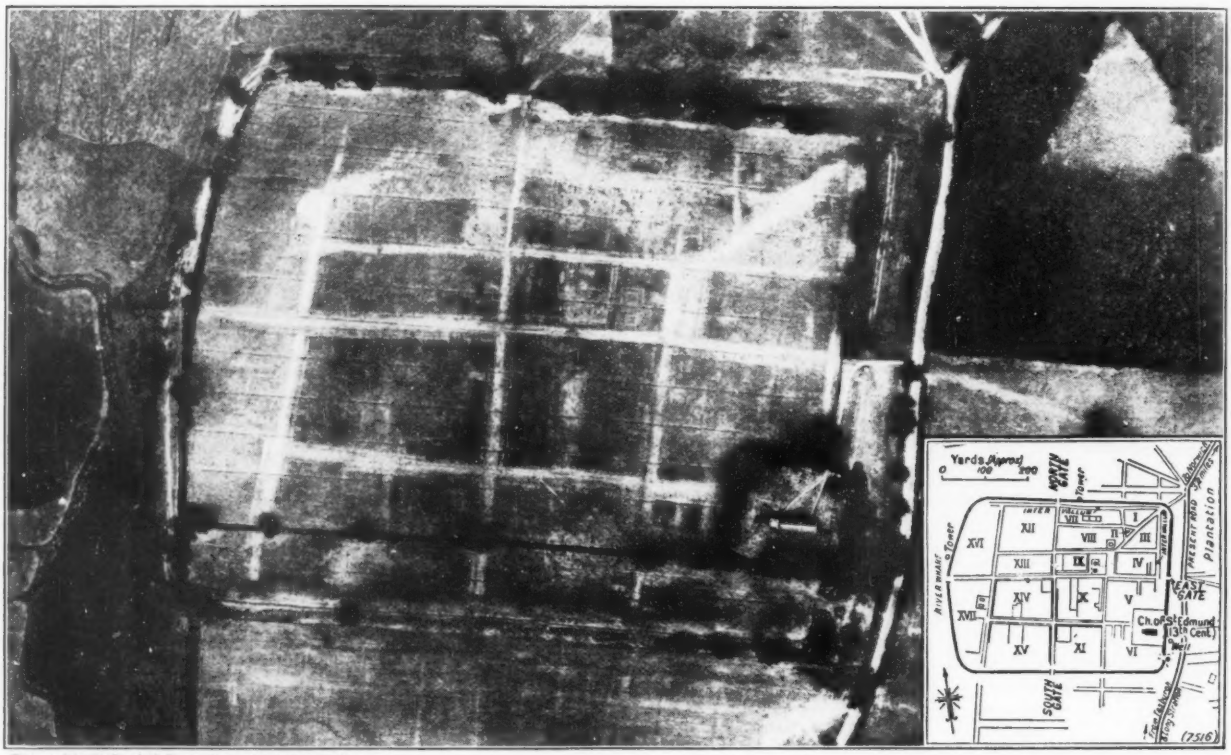
Below at left: The grape juice must be submitted to refrigeration as otherwise it will ferment. Grape juice is a popular drink

STORING GRAPE JUICE

Below at right: The great enamel-lined steel storage tanks are of 14,000 gallon capacity and are used for storing grape juice before shipping. The utmost cleanliness prevails







Photograph by the Royal Air Force. Crown Copyright reserved

A REMARKABLE PHOTOGRAPH OF A ROMAN TOWN IN BRITAIN, TAKEN FROM THE AIR

The outlines of the ancient streets and buildings show plainly, as diagrammed in the corner map. Yet none of them is actually visible on the surface, for the area is a field of ripening barley. The true explanation of this anomaly will be found in the text below

Ancient History from Aloft

A Fascinating Archeological Discovery by Aerial Photography, a Method Now Being Developed in Europe

By J. REID MOIR,
Suffolk Institute of Archeology and Natural History

ONE of the most important and extensive excavations of a Roman site in England is now being undertaken in East Anglia. About three miles to the southeast of Norwich, the capital city of Norfolk, lies the great Roman camp or town of Caistor. With the exception of Colchester in Essex, there was no place in the eastern part of England equaling in size and in importance that of Caistor. Although this is the case, no excavations have hitherto been carried out at this impressive site with its immense protecting ditch enclosing an area of no less than 35 acres. Inside the ditch are to be seen lengths of massive walls, made of flint and Roman bricks, which have withstood the slow passing of the centuries. They indicate the importance of Caistor in the far-distant past.

There is little doubt that this place was the Venta Venorum (the center of the Iceni) of the Ninth Iter of Antonius (about 320 A.D.). The Iceni were the inhabitants of East Anglia who, under their brave and warlike queen Boedicea or Boadicea, rose against the Roman rule and were only suppressed after extended and sanguinary fighting. It is possible that Caistor was the headquarters of Boadicea and this fact, together with the probability that the site was a flourishing town till towards the very end of the Roman occupation, make the excavations which have now begun of surpassing interest.

FOR many years past the plow and the activities of rabbits have brought to light at Caistor numerous coins, ornaments, utensils, and pottery. In 1846 a Roman villa was discovered and excavated in a neighboring garden. But, though these discoveries have been made, no attempt to investigate the great enclosure at Caistor had been undertaken until, under the auspices of the Norfolk and Norwich Archeological Society, aided by a number of experts, the present much needed work was initiated.

For some years it has been noticed during the summer that whenever the land within the enclosure at Caistor was covered with ripening grain curious intersecting white lines appeared where the crop had been starved of plant food owing to the roots meeting some hard subsoil or foundation. These lines, which were visible at a distance only, were thought to represent the areas where the streets of the town existed. But there were no signs above ground of the existence of buildings.

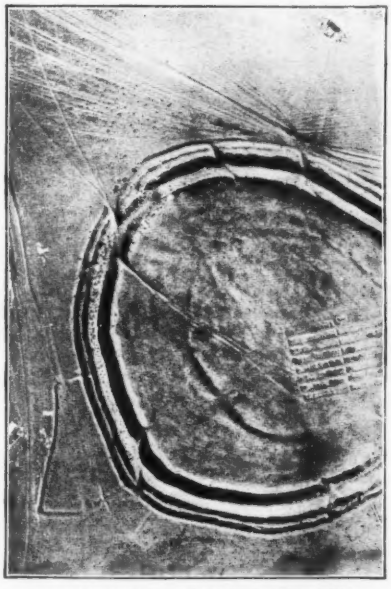
During the summer of 1928, as the barley was ripening, the lines became pronounced, and by a wise decision the Air Minister was asked to allow the Royal Air Force to practice upon this photographic target. The Royal Air Force has already rendered invaluable services to archeology by taking photographs of certain sites from the air, and thus revealing in a truly remarkable manner important details quite invisible to any investigator on the ground. The photograph of Caistor Camp taken by the Royal Air Force, must, I think, be regarded as a record

in such matters. Not only does it give an accurate plan of the streets, in some places with abutting walls; but, what is more extraordinary, it discloses the existence of many most interesting buildings within the enciente. Further, this wonderful photograph affords some evidence that the surrounding *vallum* was constructed after the streets were made, as they appear in places to continue their alignment outside the confines of the camp. This implies the existence of a Roman town before the fortification of any part of it became necessary.

The air photograph also reveals the sites of buildings which can hardly fail to be of the utmost interest and importance. Insula IX, (see insert map, in photograph) which attracts most attention, is near the northeast center and contains what appear to be two

MORE AIR ARCHEOLOGY

Badbury, a pre-Roman hill-top camp, showing ramparts and defenses. The illustrations on this page, reproduced by permission from Crawford and Keiller's "Wessex from the Air," by courtesy of The Clarendon Press, Oxford, have no connection with the illustration on the opposite page, except as examples of air archeology. These camps, unlike the other, are prehistoric but are easily visible from the surface, standing in relief



YARNBURY, COUNTY WESSEX

Earthworks around a plateau camp. Inner circle is older—perhaps earlier than Iron Age, but the grid is modern

temples. It is thought that Insula X will prove to be the forum and basilica, and it is to be remembered that the exact position of these temples, as well as of the other buildings, has been revealed solely by the slight bleaching of the barley above them. The long, parallel, thin, dark lines are, however, modern, being caused by the effect on the grain of large plow furrows.

Among the many things upon which the Caistor excavations will throw light, it is hoped that something will be ascertained about the obscure subject of Christianity in Roman Britain. A church may be found, as at Silchester, while if the whole area could be excavated and none was discovered, that in itself would be very valuable evidence.

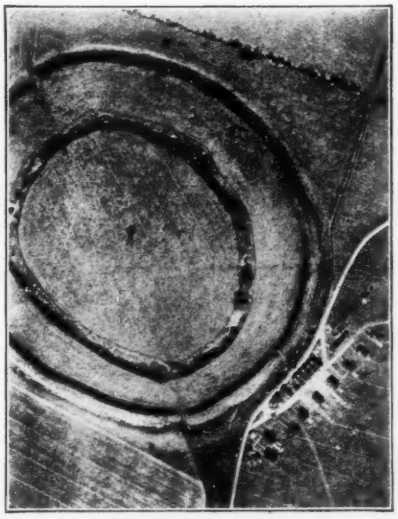
A matter of great interest which it is hoped to clear up is whether the temples remained in use for their original worship up to the end of the Roman occupation, or whether they were taken over by the Christians, or altogether desecrated. The only building above ground within the *vallum* is the ancient medieval church of St. Edmund. The photograph shows very clearly that this church was erected in complete disregard of the original planning of the town, which by then had no doubt fallen into decay and disuse. After the departure of the Romans in Anglian times, Caistor was abandoned and superseded by Norwich, so there is every reason to expect that the site will be found undisturbed by any later occupation.

It is seldom that such an opportunity for a successful excavation occurs, and the Norfolk and Norwich Archeological Society evidently recognize this fact. They have been so fortunate as to secure the services of Mr. Donald Atkinson, an acknowledged expert on such work, to supervise the diggings, and no better choice could have been made.

It is by no means easy to exaggerate the importance of the excavation of an untouched Roman town which existed throughout the whole period of imperial rule and felt the first brunt of the barbarian invasion. The Caistor site has probably never been seriously interfered with since it was abandoned by the Roman provincials about the middle of the 5th Century, and great results are confidently expected from the work now set on foot.

HOD HILL, A HILL FORT

This shows a Roman encampment within a prehistoric encampment, surrounded by modern fields. The preservation is good

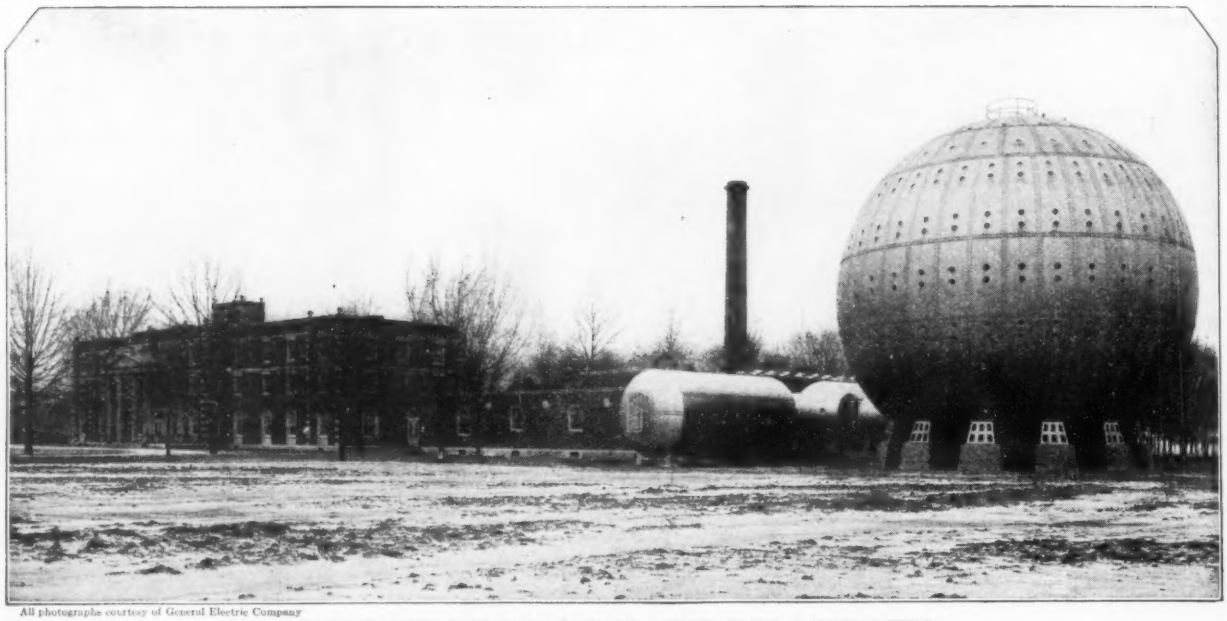


FINSBURY RINGS

This camp, perhaps an arena for chariot racing, has been scientifically excavated since the above photograph was taken

The scientific examination of such sites are of world wide interest, and archeologists and others from many countries will no doubt visit Caistor to see for themselves what Mr. Atkinson and his colleagues are discovering. Such work, however, cannot be carried out without incurring considerable expense and a subscription list has been opened at Barclay's Bank, Ltd., Bank Plain, Norwich.

There is romance, as well as history, connected with a site like the great camp at Caistor, and as the diggings proceed I shall hope to give in some future number another account of the discoveries which are made, to the many readers of the SCIENTIFIC AMERICAN.



All photographs courtesy of General Electric Company

CLEVELAND'S MILLION-DOLLAR STEEL BALL SANITARIUM

Every facility found in the usual hospital or sanitarium is provided in this unusual structure, in which victims of diabetes, anemia, and other diseases receive treatment in an atmosphere of compressed air for about five days, in addition to medical attention

Compressed Air Used In Novel Hospital

WITHIN one of the queerest hospitals ever constructed, located in the city of Cleveland, victims of diabetes, pernicious anemia, and other diseases are treated by means of compressed air. The customary aids of the medical profession are used also, including serums, medicinal preparations, and regulated diet. Rising to a height of five stories, the structure appears to be a huge silver ball with portholes in the side. The million-dollar steel ball has a diameter of 64 feet; the exterior is covered with an aluminum paint, and presents one a novel sight.

Cunningham Sanitarium, as the structure is known, was built by H. H. Timken, a wealthy steel manufacturer of Canton, Ohio, to enable Dr. O. J. Cunningham to demonstrate his theories as to an improved treatment for diabetes and other diseases. The interior of the tank is equipped with every convenience to make the patients feel at home. A dining hall occupies the first floor. The three floors in the interior of the ball are divided into hospital rooms, and on the top floor there is a recreation room.

Although the treatment is administered for a variable period from 30 to 60 days, only five days are spent in an atmosphere of compressed air. The hospital is entered through a small cylindrical tank which adjoins the Administration building. When the compressed air is released in the small tank, the patient feels as if he were falling from a skyscraper, but the effect is not harmful and the uncomfortable sensation soon disappears, it is said.

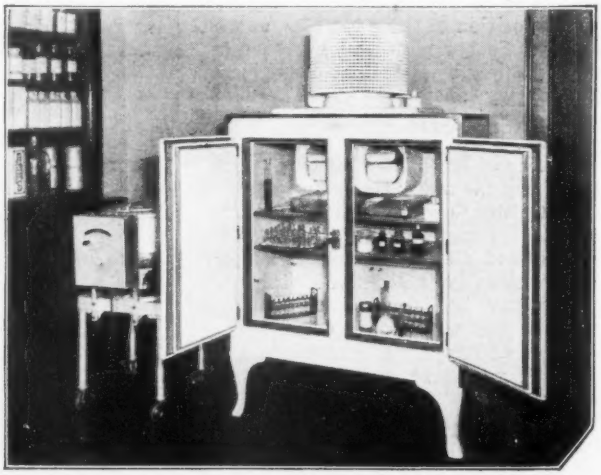
Unusual requirements necessitate the best refrigeration available, to preserve serums and medicinal supplies as well as the food for the patients. A special General Electric refrigerator mounted on a rubber-tired carriage is wheeled through the compression room into the dining room, from the kitchen in the Administration building.

LABORATORY AT THE CUNNINGHAM SANITARIUM

In this spotless laboratory are kept serums, sodium hyper-bromite, and other medical aids, which supplement the air treatment

MODERN REFRIGERATION IN A NEW ROLE

Here refrigeration is used to preserve serums and medicines, as well as food. A refrigerator mounted on wheels is used when serving



The "Heat Makes Cold" Refrigeration Unit

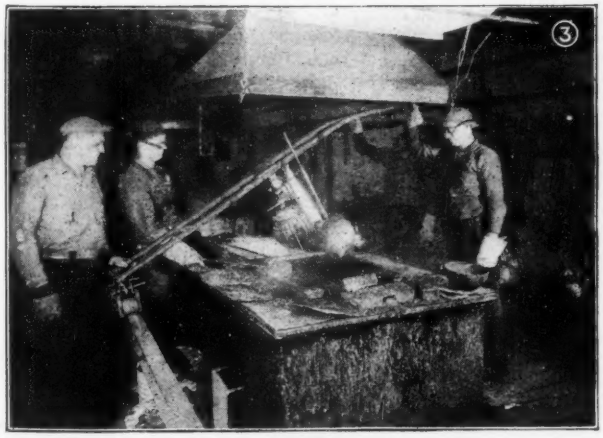
SIMPLIFICATION of design is one of the great forces in our era that is daily putting luxuries within the reach of all. The history of mechanical refrigeration affords a marked example of this process. First there was the electrical refrigerator; then came the highly efficient gas refrigerator; and now we have perhaps the simplest, most compact of all: the Icyball. This unit, which is as simple as a tea kettle, utilizes the heat of any stove—gas, oil, coal, et cetera—to keep a refrigerator cold. The fuel cost of operating it with gas is about two cents for each heating which gives refrigeration and freezes ice cubes and desserts for from 24 to 48 hours. The unit weighs about 35 pounds and consists simply of two balls that are connected with a length of pipe and equipped with a carrying handle.

In the illustration at the right, the ball with the fins is called the "hot" ball and the other is the "cold" ball. These, with their connecting tube, are sealed so that the liquid within does not evaporate even after years of use. The liquid is a solution of ammonia and water—practically the same as household ammonia—weighing 14 pounds.

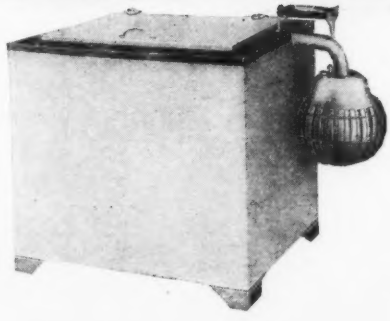
To charge the Icyball, it is lifted from the cabinet and stood on end so that the liquid all drains into the hot ball. Then when the hot ball is heated, the ammonia is evaporated out of the water and is driven, as a gas, into the cold ball where it condenses. During this heating, the cold ball is immersed in a pail of cold water to expedite condensing of the ammonia. When the process is complete, the cold ball is inserted in the cabinet, the ammonia begins to evaporate rapidly because of its affinity for water, and the evaporation causes its temperature to drop to a very low point in the neighborhood of zero.

EASY TO HANDLE

The complete unit which cools after being "charged" by heating, weighs 35 pounds



Illustrations courtesy the American Gas Association



IN ITS CABINET

The cold ball hangs inside the refrigerating compartment, the hot ball outside

The numbered illustrations on this page show steps in the making of this unit: 1—View of the assembly line where balls are welded; 2—Completing the assembly; 3—Dipping the unit into gas-fired tank of molten zinc during galvanizing process; and 4—A section of the testing department where units are fully tested.

The Scientific American Digest

Newest Developments in Science, Industry, and Engineering

Our Newest Fighting Tank

SINCE Major Campbell's article on page 216 was written, a new tank invented by J. Walter Christie, automotive engineer, has been tested at Fort George E. Meade, Maryland, before a group of military experts. The performance of this new war machine, which carries a crew of three men, was so amazing that it elicited expressions of astonishment and praise in many quarters.

Over rough terrain — soft plowed ground—the new tank made a speed of over 42 miles an hour and, with its tread removed, it made a speed of over 62 miles an hour on a concrete highway.

Technical details of this land "battle cruiser" are being closely guarded but reports state that its motive power is a single Liberty motor. Its tread, which is used when it is traveling across country on typical battlefield ground, is removed when it is desired to drive the tank on improved roads, the transformation being effected in 14 minutes. Endurance tests have not as yet been made and it is impossible to estimate just how long this racing tank will "stand up" without an overhaul. It is believed, however, to be sturdily designed and capable of long service.

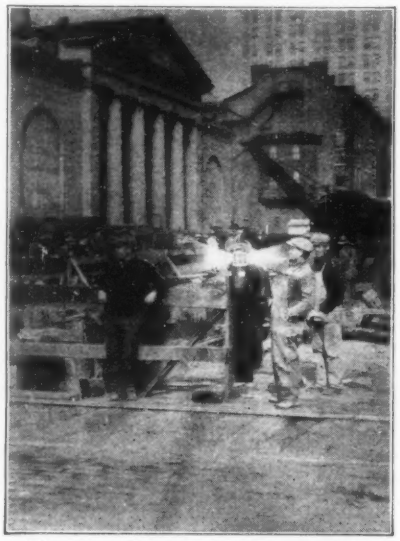
Portable Flashing Warning Lamp

THE development of an automatic warning signal, with far greater visibility than the ordinary oil lantern and more cheaply operated, has aroused widespread interest among contractors, road builders, and all concerns engaged in outside construction work.

Announcement of the development of the new signal after more than a year's research, was made recently by the National Carbon Company, Cleveland, Ohio. The new signal is known as the Everready Portable Flasher.

Research experts of the company have found that the average kerosene oil lantern costs 50 dollars per year or more, for filling, cleaning, replacement of chimneys, and depreciation. While the first cost of the flasher is considerably more than the initial cost of the oil lantern, its maintenance is said to be so much less over a reasonable period of time that it saves its cost and then makes steady reductions in upkeep. Additional savings are realized, it is said, from the fact that the greater warning power of the intermittent flash enables one flasher to displace several oil lanterns and at the same time give much greater protection.

Another distinct advantage of the flasher



The recently announced automatic warning signal lamp, the flashes from which have high visibility

is the fact that it is readily portable, the entire unit, fully equipped with batteries, weighing only 16 pounds. The batteries used are standard. The intermittent flash uses the battery capacity to best advantage, making them last much longer than they would under a steady load.

The specifications of the new signal warning are: Height, 16 inches; diameter of base, seven inches; and weight, including the large dry cell batteries, 16½ pounds.

Once it goes into operation, the flasher requires no attention whatever except to replace batteries every two to three months. It requires four standard dry cells connected in series to deliver six volts. An extra six-volt lamp is inside the battery housing. The battery compartment is constructed of seamless steel finished in red and the top is cadmium plated for weather protection. The heavy red glass lens throws a powerful warning beam. The padlock for the battery compartment has an extra long hasp so that the flasher can be chained and protected from theft. The rugged construction throughout makes the whole signal completely weatherproof.

Self-Lighting Cigarettes

IN the chemical laboratories at Ames, Iowa, Miss Annella Wieben and Dr. F. E. Brown, of the faculty of Iowa State College, have invented an igniting tip for cigarettes. This tip is on the order of a match head, although it is chemically different. It insures the lighting of the cigarette without the use of a match or other external heat producer.

The idea of a self-lighting cigarette did not originate with Miss Wieben and Dr. Brown. As long ago as 1881, a Russian inventor is known to have taken out a German patent on some such device. The chief fault with his invention, as well as with others that followed it, was the fact that a disagreeable taste and smell accompanied the lighting of his tip, which was a compound of sulfur, phosphorus, et cetera, like the old-fashioned match head.

Several inventors have since attempted to improve upon this idea and have even secured patents for their improvements, none of which has turned out to be successful.

Now come these two Ames chemists who assert that their invention meets all of the objections made to its predecessors; and, because it is simpler, more feasible, and inexpensive, they feel that it gives every promise of being a complete success.

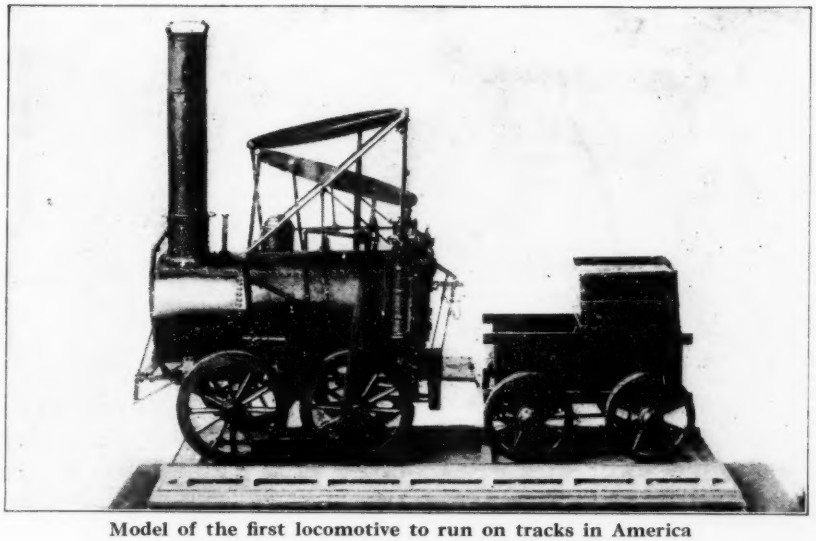
The high-speed tank which was recently tested at Fort George E. Meade. It is the fastest in the world

The new tank races over rough ground with the speed of an automobile or, with tread removed, on highways

The composition which they use in tipping their cigarettes is such that it ignites readily when rubbed on a specially prepared surface much like that used for the lighting of safety matches. This scratching surface may be attached directly to the package of cigarettes. There is no more danger of burning pockets or coat-tails with this substance than with a box of safety matches.

Perhaps of even more interest to the smoker is the fact that this latest tip will ignite even in a high wind and, above all, in every case it will stay lit. Furthermore, the new tip lights with very little flare, without giving off any odoriferous or harmful gas, and without affecting the cigarette's flavor—chief objections to other inventions of this sort.

A number of several well-known brands of cigarettes having the new "match" tips were tried by the editors and so far as they are able to judge, the statements in the preceding paragraphs are true.



Model of the first locomotive to run on tracks in America

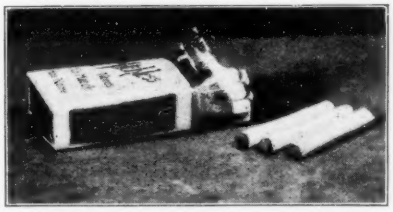
America's First Locomotive

IN our August 1929 issue we made brief reference to the locomotive *Stourbridge Lion* in connection with an item concerning the growth of the railroads. Since this locomotive was the first to run on rails in this country and August 8th was the centennial of this epoch-making run, a few remarks concerning it should prove of interest.

On July 16, 1828, Horatio Allen, a resident engineer during the construction of the Delaware and Hudson Canal, was sent to England for railroad iron and to have four locomotives built under his supervision. At that time not a single railroad steam locomotive had ever turned a wheel on any track in the United States. Mr. Allen ordered four and the *Stourbridge Lion*, built by Foster, Rastrick and Company, Stourbridge, England, was the second to be delivered, reaching New York on May 13, 1829. Its cost delivered was $2914.90. This locomotive, together with the *America* which had arrived in New York at an earlier date, was sent up the river on July 2nd. It reached Roundout on July 3rd and was sent from there up the canal to Honesdale, Pennsylvania.

At Honesdale, Horatio Allen was waiting to receive the *Stourbridge Lion* and under his direction it was placed upon a track which had been built three miles into the woods to the site of Seelyville. Mr. Allen unaided and alone drove this locomotive the full length of this track, partly over a curved trestle, and returned to the starting point by reversing the engine.

As a fitting memorial to this national event the citizens of Honesdale, Pennsylvania, observed on August 8, 9, and 10, 1929, a celebration which included the dedication of a monument, a transportation parade, and other ceremonies.



"Matchless" cigarettes that light when their tips are scratched on the side of their own container

It is not always possible to skid logs by gravitation to water or to railroads; sometimes the job is uphill work. Here, three "Caterpillar" sixtys, in tandem, are towing a redwood log containing 8200 board-feet to the railroad for shipment. The log is 20 feet long and weighs more than the three tractors

Static Electricity Imperils Cotton

IT does not seem likely that 12,000,000 matches got mixed up with the cotton crop in one year. Yet that is the number that would have been necessary to cause all the fires recorded at ginneries—if matches had been the cause. Government scientists mixed 600 matches with seed cotton and ran it through a gin, causing only four small fires in the huller breasts. Looking for another cause, they found the old culprit, static electricity. This is generated wherever there are moving parts and must be carried off to the ground by a good electrical conductor to remove its danger. Where belts are used it is particularly likely to occur in damaging quantities.

Evidence was found that it was the major cause of fires in cotton gins. Distributors of gasolines and oils have long been aware of its danger. That is why oil trucks invariably have a loose chain suspended from the chassis and dangling along the ground. It carries off the static electricity generated by the sloshing of the oil in the tanks.—*New York Herald-Tribune.*

Radio Does not Make Rain

DR. JOHNSON has immortalized a brief chapter "concerning snakes" whose full text is: "There are no snakes to be met with throughout the whole island." Thus it is with the alleged effects of wireless on weather. The Symons memorial lecture of the Royal Meteorological Society for 1929 points out that the average rainfall of England requires for its production the expenditure of energy at the rate of a third of a million horsepower per square mile night and day throughout the year. This is the rating of the largest electricity generating station in Great Britain. The total rate of emission of energy from all the broadcasting stations of Great Britain and Northern Ireland, in the limited periods

(*Please turn to page* 263)

Learning to Use Our Wings

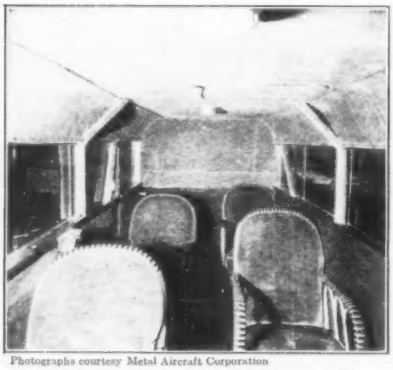
Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York City

The "Flamingo," a Metal Plane

AMERICAN airplane constructors are rapidly turning to the all-metal type and the *Flamingo*, built by the Metal Aircraft Corporation of Cincinnati, is an interesting example.

In outward appearance the *Flamingo* is neat, but conventional. It can be equipped with either the Pratt and Whitney 410-horsepower Wasp, or the Pratt and Whitney 525-horsepower Hornet. The



Photographs courtesy Metal Aircraft Corporation

The luxurious interior of the all-metal *Flamingo* described herewith

seating capacity is 8. There is a mail and baggage compartment of 40 cubic feet. The span of the wing is 50 feet, and the over-all length is 32 feet 6 inches. The weight empty is 2960 pounds, and the weight fully loaded is 5600 pounds. The pay load is about 1400 pounds. The high speed with the Wasp is 135 miles per hour; with the Hornet 140 miles per hour.

In the early flying days, an airplane was an airplane, and very few instruments or accessories found their way into its construction. It is interesting to list what a well equipped machine of to-day carries as its ordinary equipment. Hand inertia starter, booster magneto, ignition switch, altimeter, tachometer, oil pressure and temperature gages, fuel pressure gage, 8-day clock, magnetic compass, air-speed indicator, navigation lights, canvas engine cover, engines and airplane log books, and first aid kit. This constitutes an imposing list which leaves little else to be desired.

Apparently the constructors of the modern airplane are not afraid of an all-metal covering for wings and fuselage; on the *Flamingo* this covering is .014 inch thick, and is therefore far heavier than fabric covering. The permanency of such a covering evidently makes it worth while to make some sacrifice in the matter of weight. Also, the metal covering does add to the strength somewhat. For local stiffness the metal covering is corrugated on three-inch centers with a semi-circular corrugation.

The spars of the wing are of "I" section, the flanges being built of extruded dural angles, with a dural web set between them. There are 36 ribs in the wing, made of flat dural sheet and all exactly alike, with holes punched and flanged to give lightness and rigidity. The construction of these ribs is but one example of the production methods which it is possible to apply when metal is boldly used.

The fuselage is of welded seamless steel tube throughout. The metal skin is fastened to light dural channels riveted to clips placed on the tubes.

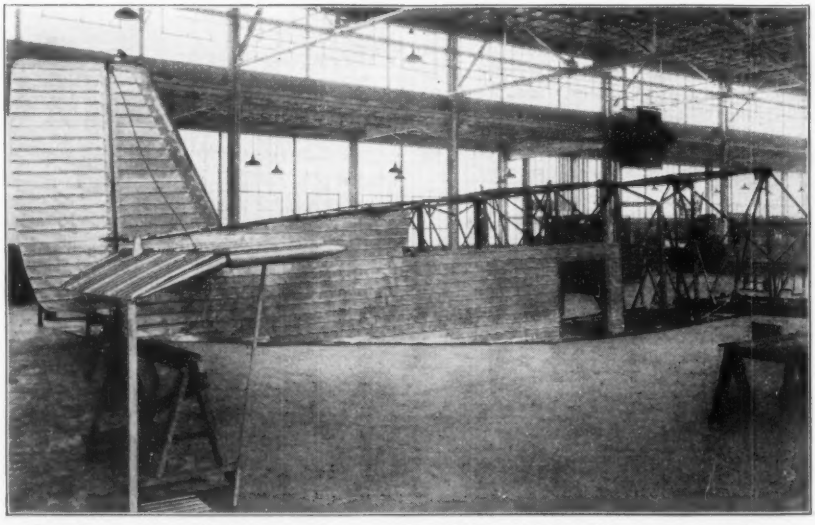
The main cabin is 50 inches wide, 60 inches high and 14 feet long. It is fitted with upholstered reed chairs secured to the floor.

Gliding in Germany

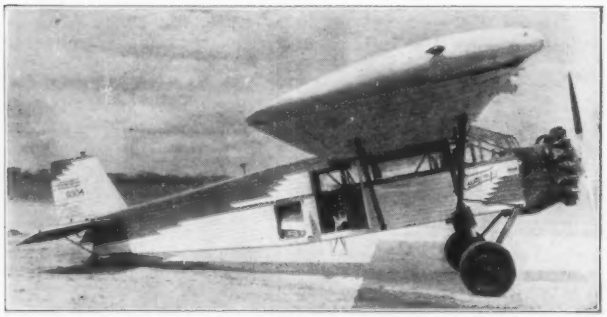
IN the *National Geographic* for June, 1929, Howard Siepen has a beautifully illustrated article entitled "On the Wings of the Wind." This is a most fascinating description of gliding as now practised in Germany and it contains many lessons for glider enthusiasts in this country.

There are in Germany to-day some 200 glider clubs, and in 1928 about 10,000 glides and flights were made. At last year's competition, in the Rhon Valley, 105 machines participated.

What is particularly interesting about the glider movement in Germany is that it introduces the schoolboy to the air. No boy should learn to fly a powered machine until he is at least eighteen years of age. But gliding instruction in Germany is open to



Fuselage of metal plane, partly covered with dural skin. Note tail assembly



Side view of the all-metal *Flamingo* equipped with a Pratt and Whitney Hornet engine of 525 horsepower

Showing the great strength of the wings of this all-metal plane. On the wings are 55 men, 10,090 pounds

Photograph by Howard Siepen, courtesy of the *National Geographic* magazine. © 1929

By means of long elastic ropes, gliders are snapped into the air

any schoolboy of fourteen years or over. Hundreds of schoolboys are now flying, and three thousand took flying instruction in 1928. Instruction is free and it is given by the school teachers themselves. This is said to be reassuring to parents, and no doubt it is. Also, in schoolboy instruction, only primary gliders are used, and these primary machines seldom glide more than 10 or 12 feet from the ground so that hazard is reduced to a minimum. Moreover, at the technical schools and universities, students form clubs for the construction and operation of gliders and have produced some really remarkable craft.

The glider movement in Germany is supported by airplane manufacturers and plane associations of various kinds. The thought back of the movement is that by gliding, the younger generation will become air-minded, and that the best pilots of the future will be produced in this manner.

The article brings out a distinction which is not always made in the United States between the glider and the "sail plane." A glider is a machine which, elevated a few feet in the air or launched from the side of a hill, will glide steadily downwards. A "sail plane" is a finer, more lightly built craft which, taking advantage of upward currents of air, will actually sail or fly in the hands of a skilled pilot.

Another valuable feature of glider work is that the student takes his first glide after merely verbal instruction. On his very first attempt he takes full charge. A man who begins training in this way is likely to become a more natural flier than the man who receives instruction in a dual, powered plane. Powered flying will come very easily after such practise.

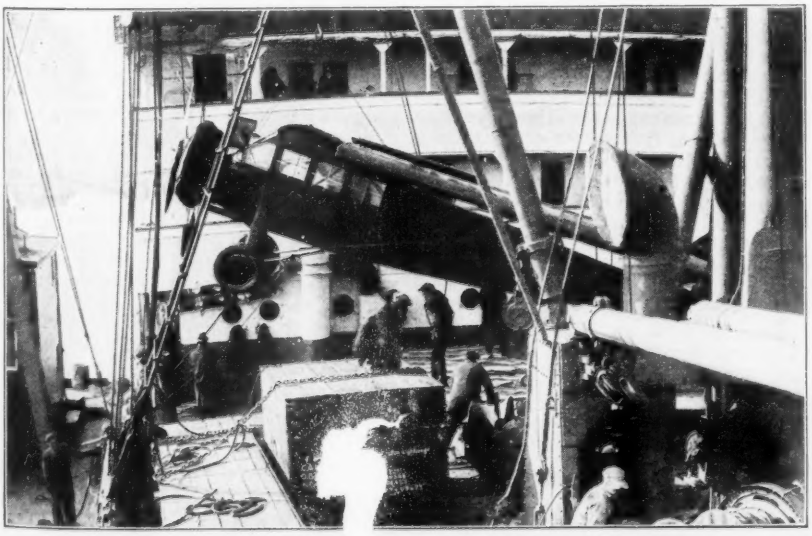
The sail planes have now reached a wonderful stage of development. Some of them have a wing spread of 59 feet and a chord of only five feet. This large "aspect ratio," together with the beautiful shape of the fuselage gives them a gliding ratio of 20 to 1, which is far better than the efficiency of any airplane. The airplane will ultimately approach the glider in efficiency, but it has a long way to go as yet.

It must be almost as much fun to launch a glider as to fly one. The pupil takes his seat and pulls back his stick so that the glider is ready to take the air. The instructor holds the ship on an even keel. At an order, two starting groups walk ahead, gradually drawing out the rubber launching. Then they run. Then the order to let go is given, and two men holding the tail of the glider release it. The elastic ropes launch the glider into the air as from a catapult. It is essential that the release mechanism for freeing the launching ropes from the glider function perfectly, as otherwise the maneuver is ruined.

Exporting Aircraft

AMERICAN exports of aircraft and aircraft engines are steadily growing. In 1925 the total value of aircraft exports was 783,658 dollars; in 1926 it had grown to 1,027,210 dollars; and in 1927 the value had risen to 1,903,560 dollars. The figures for 1928 are still larger. The principal markets for 1927 were Canada, Peru, Chile, and Soviet Russia. South America is a particularly attractive territory for the American manufacturer, and now that the Curtiss interests have formed a company to operate in China we may expect large exports across the Pacific.

In the early days after the war, Europe practically barred American products from the rest of the world, mainly because labor costs in Europe were so much lower. But as the industry attains a production basis, the superiority of American production methods begins to assert itself. Our photograph shows a Fairchild monoplane swinging aboard the Grace steamer, *Santa Theresa*. The plane is to be landed at Callao, the Peruvian Naval Base, where it will be equipped with pontoons. From there it will be flown to Lima for service over the Peruvian Airways, a line carrying passengers, mail, and express to the interior. The folding wings of the Fairchild monoplane make this plane particularly convenient for shipment by steamer.



A monoplane made in e United States, bound for Peru

Financing Aircraft Sales

IT is estimated that at the present time at least 50 percent of all motor cars are sold on the installment plan, and there is no doubt that adequate financing has greatly furthered the sale of automobiles, and there is reason to believe that many airplanes will be sold in similar fashion. At any rate, a number of airplane finance companies are already functioning and several types of planes have already been sold on some time plan or another. The Aviation Credit Corporation has issued an interesting pamphlet regarding its plans for financing of this kind.

The airplane distributor can now purchase planes by paying down only 10 percent of their price and receiving credit for the balance over a period ranging between three and six months. The rates of interest are to be the same as is the case with the automobile. An insurance policy covering fire, theft, and windstorm is placed through the finance company.

From the private owner the finance company will require a cash payment of 33⅓ percent, and the insurance policy required will be of a broader character, covering accidental damage, public liability, and passenger hazard in addition to the risks previously listed.

The financing of aircraft sales certainly deserves every encouragement.

The Month in Medical Science

Progress in the Medical and Surgical Fields

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

The Weather and Pain in the Joints

FOR many years sufferers from "rheumatism" have said that their pain is worse in bad weather; and every village has its old inhabitant who can invariably predict a change in the weather by the pain in his joints. The impression is so definite on this subject that investigators in the Mayo Clinic determined to make a scientific study of the subject. Even Hippocrates noted that people living where cold winds prevail are more prone to acquire certain types of diseases than those who live in a climate not subject to cold winds. In the last 150 years many investigators have attempted to correlate barometric changes and rainfall with the occurrence of inflammations of one type or another.

In the investigations carried out by the Mayo Clinic, records were kept of the barometric pressure and the severity of the pain of the patient as estimated according to a definite scale over a long period of time. In addition, note was made as to whether the weather was clear and sunny, fair, cloudy, or included rain and snow. It was found that the presence of a storm was always associated with increased pain and that patients complained less on clear sunshiny days. The general improvement following a continued period of fair weather was always striking.

It was also found that there was a definite relationship between pain in the joints and the approach or presence of storm. One morning when the sun was shining brightly and there was not a cloud in the sky, 12 patients with inflamed joints seemed to be getting along excellently. Early in the afternoon one patient after another began to call for relief from pain, although the sky was still clear and sunny. Later in the afternoon an electrical storm suddenly appeared. Daily observations were made of temperature, humidity, and atmospheric electricity.

As a result of their studies of 367 patients over a period of a year, the authors conclude that there is a positive relationship for 72 percent of the time between the curve of pain and that of barometric pressure. For 21 percent of the time the relationship was equally as definite, but as one line went up the other line went down and only 7 percent of the time was the relationship undemonstrable. For more than 90 percent of the time there was a definite relationship between the presence of storm and increase of pain. The observations on humidity, temperature, and atmospheric electricity were inconclusive, but it is possible that all of these factors working together may have had some effect.

Arsenical Poisoning

IT has been known for many years that people who work in industries in which arsenic is involved have hair which is particularly glossy and a skin which is peculiarly pale. However, the definite relationship between the arsenic taken in and the effects on the skin and hair have been previously fully worked out. In 1927, six members of a family and the hired man on a farm in Sonoma County, California, developed severe arsenical poisoning. An investigation by the State Board of Health revealed the fact that arsenic, lead, and phosphorus poison, used for the extermination of rats, had been kept in a cupboard and that the father of the family who prepared the breakfast had by mistake put arsenic in the hot cakes instead of baking powder.

Drs. Theodore L. Althausen and Lewis

View of the hands of a person with acute arsenical poisoning, showing areas of pigmentation and white bands across the nails. See descriptive text in these columns

Gunther decided to investigate these cases with special reference to the excretion of arsenic through the hair. Arsenic is found in the hair after taking a single or repeated doses of the substance, but it does not appear there for many hours after it can be found in abundance in the internal organs. At the earliest, it has been demonstrated in the hair five days after the poisoning occurs. However, the hair content of arsenic per unit of weight exceeds that of all of the other tissues and the excretions of the body in chronic cases of poisoning with this material. Furthermore, the hair contains the arsenic much longer than any other structure of the body, including the liver and the bones, a fact which is accounted for by the continuous depositing of arsenic in the hair from all over the body. It is, of course, important to remember that the arsenic in the hair is not re-absorbed for excretion through other channels. The authors also noted, following arsenical poisoning, the appearance of white transverse bands on the finger and toe nails, which they account for by the deposit of arsenic in the nails.

The Danger of Ethylene

DURING the past few years newspapers have occasionally reported explosions of ethylene gas, so that many directors of hospitals and many people among the public have come to associate the use of this substance with special hazards. Unfortunately the newspapers do not print records of the successful anesthesias with this substance and the point of view becomes badly distorted.

In order to discover the exact state of affairs, Dr. Moses Salzer sent a questionnaire to 478 hospitals to find out whether or not they use ethylene and whether or not they have had explosions during its use. His records indicate that 425,000 ethylene anesthesias had been induced and that there were only 10 explosions—one in every 42,000 cases. Some of these explosions were mere flashes, such as can occur with other anesthetics. There were three instances of minor injuries, four instances of destruction of equipment, and one death. Doctor Salzer is convinced, as a result of his survey, that from the point of view of explosion, ethylene is safer than ether.

Sensitivity to Food

NOT infrequently people suffer from bleeding under the skin. The spots appear suddenly following brief attacks of abdominal pain, sometimes including also the development of blisters and bleeding from the gums. Recently physicians have come to associate the appearance of this combination of symptoms with specific sensitivities to various food substances, the symptoms representing reactions by the body to the ingestion of the food to which the person might be sensitive.

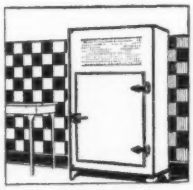
Drs. H. L. Alexander and C. H. Eyermann of St. Louis have recently reported six cases of this type. In one, the removal of milk from the diet resulted in complete recovery. In another, egg, potato, and wheat were the substances involved. Removal of these substances resulted in recovery and feeding of these substances invariably produced the symptoms. In a third case, that of a woman of 32, eggs, chicken, beans, fish, and lamb invariably induced abdominal pain and headaches and the avoidance of the offending products brought relief from the symptoms.

A boy 14 years of age was sensitive to red plums. A woman 50 years of age developed abdominal pain, bleeding under the skin, and sneezing following the eating of wheat products. Another woman developed abdominal pain, blue spots under the skin, and painful joints following the eating of pork, onions, or strawberries. She invariably remained well while avoiding these foods. Tests made with small doses of the extract material rubbed into the skin revealed the sensitivities.

Many of the unexplainable symptoms of the past are now being brought into the group that is called by the physician "allergy."

A cold place to keep eggs, a warm place to hatch them ..made with this grainless wood

There are hundreds of industrial applications for the grainless wood board, Masonite Presdwood. The Presdwood booklet lists eighty of its uses and may suggest ways in which you, too, can use Presdwood to improve a product or lower manufacturing costs. A sample of Presdwood and a copy of the booklet will be sent, free, on request.



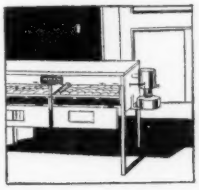
FOR ICEBOX CABINETS

A de luxe ice box, that is made in Detroit; an incubator, which comes from Racine; an outdoor sign from Kalamazoo, advertising baby chicks. These things and scores of others, ranging from tiny toys tc monster motor truck bodies, are now made of this grainless wood, Masonite Presdwood.

For panels, painted or unpainted

The entire outer cabinet of the ice box is made of this grainless material because of its hard, smooth surface on which commercial finishes can be so readily applied. The incubators are made of Presdwood because it is weather resisting, strong, easily punched or cut with any woodworking tools and so naturally attractive that a paint finish is not required.

Carload after carload of Masonite Presdwood goes to makers of signs of all kinds. The sign builder at Kalamazoo is just one of many. He cuts out giant "chicks" as advertisements and sells them to breeders of fancy poultry who wish to advertise their business along near-by roads.



FOR STURDY INCUBATORS

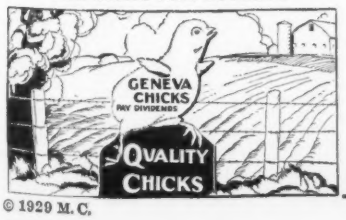
Presdwood is used for scores of other things. It makes smooth beds and rails for portable billiard tables. It makes cooling trays for castings, starch trays for candy factories, bedroom screens, doll houses, toy animals for children to play with. It panels walls and ceilings of fine homes and the offices and corridors of the better type office buildings. Used to line concrete forms it gives such a perfect, smooth surface that the need for hand rubbing and grinding is eliminated.

Send for this booklet

Eighty uses for Presdwood, many of them attractively illustrated, are listed in the Presdwood booklet. It will certainly pay any industrial executive, builder or home owner to get a copy and learn more about the advantages of wood that is grainless. The booklet and a sample of Presdwood will be sent, free, on request.

MASONITE CORPORATION
Sales Offices: Dept. 741, 111 West Washington Street
Chicago, Illinois

FOR SIGNS AND CUTOUTS



Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION
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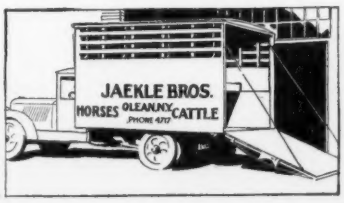
FOR MOTOR TRUCK PANELING



© 1929 M. C.

Chemistry in Industry

Advances Made in Industrial and Experimental Chemistry

Hydrogenation Comes to Revolutionize Gasoline Production

WHAT is probably the most significant recent development in the whole realm of industrial chemistry was recently announced by the Standard Oil Company of New Jersey—a revolutionary process for the production of gasoline from petroleum. By ordinary distillation, a gallon or crude oil can be made to yield a certain amount of gasoline. This maximum yield would not produce nearly enough gasoline to take care of the present demand and the motoring public is indebted to Dr. W. M. Burton, who, some years ago, developed the "cracking" process, whereby the yield of motor fuel from crude was greatly increased by breaking down more of the higher hydrocarbons in petroleum to gasoline. Now, however, comes an entirely new process, whereby *all* of the crude oil is converted into gasoline by hydrogenation. Whereas "cracking" is a *destructive* process, hydrogenation is a *constructive* reaction, actually building up gasoline from atoms of carbon and hydrogen.

This revolutionary development was first announced in the pages of *Chemical and Metallurgical Engineering* by S. D. Kirkpatrick, who explains that by this high-pressure, high-temperature, catalytic process, fuel crudes and the heavy residues of the ordinary refining process can be converted almost quantitatively into gasoline or other more valuable petroleum products. A semi-commercial plant has been in successful operation at Baton Rouge, Louisiana, for about a year, and construction is now going forward on the first of two large plants that will compare in output with an average oil refinery.

By the introduction of hydrogen under pressures varying from 100 to 300 atmospheres and in the presence of a catalyst, it is possible to build up or synthesize the hydrocarbons desired and thus to convert approximately 100 percent of the original oil into gasoline or other products of more value. Carbon formation is actually eliminated and the production of fixed gases is reduced to a minimum. Thus the chemical engineer has again demonstrated that in large measure true conservation of our oil resources lies in their scientific utilization. This process alone promises to make more valuable millions of barrels of low-grade fuel oil and residues.

The research program of the Standard Oil Company (New Jersey) has been carried on by the Standard Oil Development Company, both in the company's engineering laboratories at Bayway, New Jersey, and at the Baton Rouge refinery of the affiliated company, the Standard Oil Company of Louisiana.

Organic Substances Reduce Boiler Scale

COMMERCIAL tannin extracts, such as chestnut-oak, are efficient in removing dissolved oxygen from boiler waters and thereby controlling corrosion in many cases, according to A. H. Reynolds of the Dearborn Chemical Company who presented a paper on the subject before a recent meeting of the American Chemical Society. Boiler pressures up to 130 pounds do not destroy this oxygen-absorbing power.

Operating results, according E. M. Partridge of Paige and Jones Chemical Company, also show that harmful scale formation may be prevented at low cost through the use of organic matter in conjunction with quantities of inorganic chemicals far below the amounts necessary to react chemically with the scale-forming constituents of the feed water. The organic matter possibly acts in such a manner that the calcium sulfate and other solid materials formed during evaporation are kept in suspension rather than carried down as a sludge. The best results have been obtained by combining the lime-soda softener with the organic material treatment.

Investigate "Spotting" of Electroplated Metals

MANY electroplated products, especially those that are plated with brass or are given an "oxidized" finish, show a tendency toward the development of dark, unsightly spots on the surface. This defect, commonly known to the platers as "spotting out," has at times proven very serious in certain industries, such as the manufacture of builders' hardware. The American Electroplaters' Society, composed of foremen electroplaters, collected from their members and from firms engaged in plating, funds for researches on electroplating at the United States Bureau of Standards, and selected "spotting out" as the first problem for study.

The investigation has shown that there are two entirely distinct types of spotting. The "crystal spots" appear as dark radiating crystals upon metals that have a finish of copper sulfide (the so-called "oxidized" finish), and that are subsequently lacquered. The "stain spots" appear principally upon cast metals in the form of irregular areas of variable color.

The crystal spots are caused by the absorption of minute amounts of sulfur or sulfur compounds from the surroundings. Free sulfur (which may be used in certain plant operations), rubber bands, or wrapping paper or cartons containing small amounts of sulfur may cause this defect to develop. The only effective remedy is (1) the application of a lacquer which is nearly impervious to sulfur; (2) the application of a very thin film of grease to the lacquered surface, and (3) the use of waxed paper for wrapping the articles.

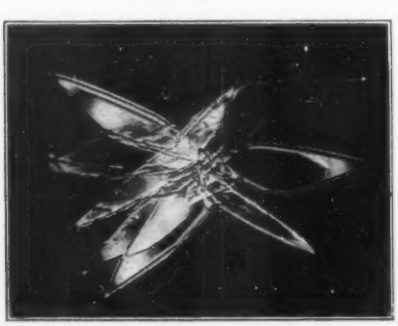
The stain spots result from the presence of minute pores in the metal, and the absorption in these pores of chemicals, either acid or alkaline, during the operations of cleaning and plating. When such articles are subsequently exposed to an atmosphere with high humidity, moisture is absorbed by the materials in the pores, which then exude and stain the surrounding metal.

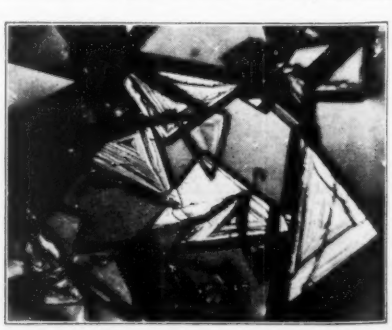
Some improvement can be made by using less porous castings and by allowing the chemicals to "spot out" from the pores before the final finishing. The most effective remedy is the application of such lacquers as have been found to retard or prevent the spotting.

Investigate New Sources of Potash

WITH the passage by Congress of the Winter bill during the past session, the way is open for a further extension of investigations into the potash resources of the country, according to the United States Bureau of Mines, Department of Commerce. Previous governmental investigations had been limited to the exploration for potash deposits in Texas and New Mexico, which geological data indicated as being present but which had not been proven. By the provisions of the Winter bill, investigations are authorized to cover other potash minerals, such as the leucites and alunites, greensands, and other potash ores.

In order to carry out research on the extraction of potash from leucite, alunite,





ABIETIC ACID CRYSTALS

These pictures, reminiscent of the view through a child's kaleidoscope, are photomicrographs of abietic acid crystals "grown" under different conditions imposed by the chemist. The triangular crystals at the right were formed from an alcoholic solution, and the flower-like cluster at the left was "grown" in rosin of high acid number

CARS THAT STAY YOUNG

Go . . . . fast or slow . . . . youth yearns to burn up distance . . . . but what is distance to Timken-equipped cars?

Noise is stilled, gears and shafts run true and miles leave only speedometer totals to mark their passing.

Abiding car youth is founded upon this exclusive combination: Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken-made steel.

Would you have Cars That Stay Young? Make sure of "Timken Bearing Equipped" in differentials, pinions, transmissions, wheels, steering pivots and fans.

THE TIMKEN ROLLER BEARING CO.
CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

and other potash-bearing minerals, the Nonmetallic Minerals Experiment Station, of the United States Bureau of Mines in co-operation with Rutgers University at New Brunswick, New Jersey, is enlarging its facilities to include work on leucite and alunite in addition to the work now in progress on New Jersey greensands, and saline minerals from Texas and New Mexico. Equipment is being installed to conduct unit chemical engineering operations such as crushing, roasting, clacining, digesting, leaching, precipitating, clarifying, filtering, evaporating, et cetera. The scale of operations is the next stage beyond that of the chemical research laboratory. It is designed to be the smallest scale in which the processes can be carried out with the same materials and with the same type of equipment as would be used in the large-scale plant.

Chemistry Contributes to Improved Explosives

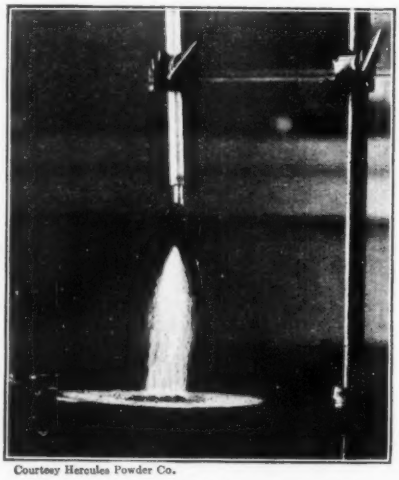
WE seldom stop to consider the many uses of explosives in producing the materials and conveniences of modern civilization. In mines and quarries, vast quantities of industrial explosives are used to blast ore and rock from its native source, while modern road and building construction is largely dependent upon the effectiveness of dynamite. Even the up-to-date farmer uses explosive to remove stumps and dig ditches. Because of the varied applications of the product and because the manufacture of explosives is so thoroughly dependent upon chemical science, the chemist finds a fertile field for his genius in research work in the explosive industry.

Ammunition for the Army and Navy and for sportsmen also constitutes a steady market for explosives. Since the World War, many improvements have been made in the quality of smokeless powder.

One of the important developments in dynamite manufacture is the production of low-freezing explosives which has greatly increased the safety factor in the mining industry, according to Dr. Charles E. Munroe, chief explosives chemist, United States Bureau of Mines, Department of Commerce. Frozen dynamite is a most objectionable and dangerous substance, for the frozen sticks or cartridges tend to become rigid, Dr. Munroe points out. For loading into boreholes it is desired that the dynamite sticks shall be plastic so that they may be readily pressed into place. There is also the likelihood that rigid sticks may be ignited or exploded by friction against the walls if forced into a borehole.

Frozen dynamite is difficult to detonate. Hence a grade of detonator which is quite capable of firing the unfrozen dynamite, and may be depended on to fire it, may not fire frozen dynamite at all, so that a misfire, with all its attendant evils, may result, or it may cause a partial explosion, or burning, giving off large quantities of poisonous fumes into a mine. Naturally such shots are not only a total loss, but, more than that, they are a source of additional expense and of danger. Consequently, users of dynamites have been strenuously warned against using frozen dynamite and advised to store their dynamite in such a manner as to prevent its becoming frozen, or if it became frozen, to thaw it before use.

As has repeatedly been found true in the development of many inventions, all this time simple means for the prevention of dynamite freezing were right at hand. The principle was well understood and widely applied, even in domestic operations. And when the method was worked out and successfully applied to dynamites it was so obvious as to excite wonder that it had not been applied years before. The principle is made use of in freezing ice cream mixtures where a lower temperature than the freezing point of water is sought and is obtained by putting common sea salt on the ice used.



Courtesy Hercules Powder Co.

Man-made lightning is directed on smokeless powder to determine its sensitivity to static electricity

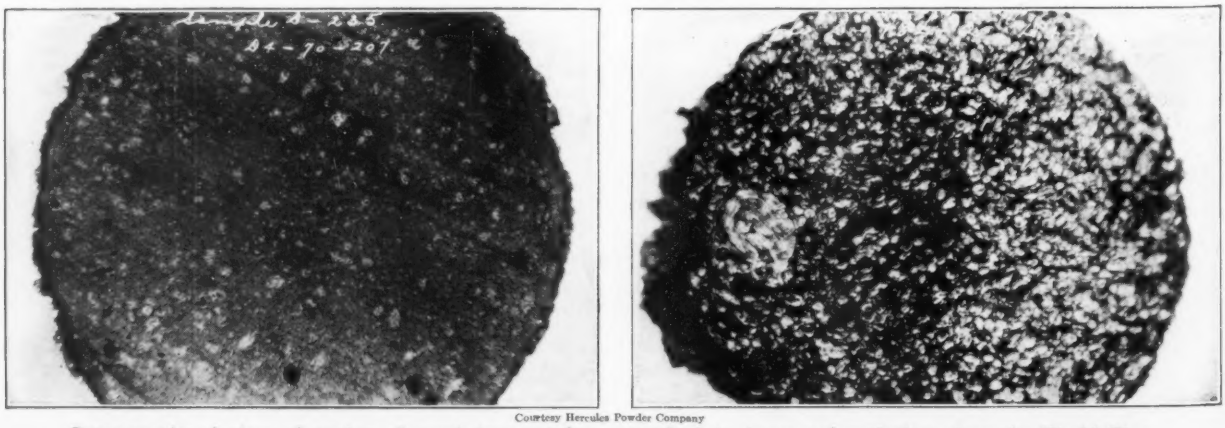
It is common knowledge that when sea salt is dissolved in water the temperature of the liquid falls below the freezing point of water and that a lower temperature is required to freeze this salt water than is required to freeze fresh water. A great variety of other inorganic salts, such as potassium carbonate, calcium chloride, ammonium chloride and others have been similarly observed to cause a fall in temperature as they dissolve in water, each to its own point, some of them producing very low temperatures, and in each case the freezing point of the solution thus formed was proportionately low. Further observations demonstrated the fact that this behavior was not confined to water but extended to many liquids, and that it was not confined to inorganic salts but that it extended to many organic compounds.

That this is a principle of very wide application became apparent but its use for the reduction of the freezing points of explosives came about rather by chance observation than through the systematic application of the principle.

By the beginning of the present century the explosives industry had attained large proportions. It was looked upon as a very profitable industry and many inventors were inspired to discover new explosive substances or to prepare new explosives combinations that they might share in this prosperity. About 1902 much interest began to be taken in the use of the trinitrotoluenes as military explosives. In the nitrating of toluene a considerable amount of tarry liquid residue was produced which the manufacturers were ready to dispose of at almost any price, and as it was cheap, apparently abundant, and possessed some moderate explosive qualities, the thought occurred of incorporating some of it into dynamite dopes. The resultant dynamite developed good qualities and in its use it was observed that it did not freeze under the conditions when other dynamites in use froze. It was not long after this that low freezing dynamites, designated as L.F., and containing "liquid nitrotoluenes" as a component, appeared in the market.

With the outbreak of the Great War, the nitration of toluene became so perfected that the "liquid nitrotoluenes" were no longer available for use in dynamites. Moreover a growing shortage of glycerin

(*Please turn to page* 260)

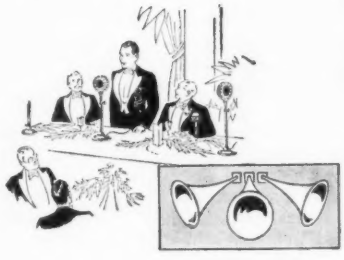


Courtesy Hercules Powder Company

Cross sectional view of grains of smokeless powder, magnified approximately 100 times. Research has resulted in improved explosives since the World War, and high explosives are now handled with less danger

Widen the Circle . . .

Let the people in the *rear* seats HEAR



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More and more hotels are turning to the Public Address System as a means for making their meeting rooms more popular. It is moreover a medium of economy because it permits a single orchestra to play at the same time in restaurant, grill, lobby, and everywhere else that loud speakers have been installed.

The apparatus which thus "widens the hearing circle" is made with all the skill and care which have so long characterized the manufacture of telephones and communications apparatus by Western Electric. It is clear toned, faithful in reproduction, dependable, modern. It has a wide variety of uses and is made in sizes to fit every need.

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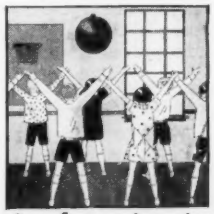

One of many interesting uses of Public Address in the schoolroom.

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Aviation

OFFICIAL AVIATION GUIDE is a new monthly bulletin presenting official up-to-date data regarding the nation's airways. It is a clearing house for information concerning the passenger and transport lines, and contains detailed time tables, schedules, routes, fares, and incidental information. *John R. Fletcher, Publisher, 105 West Adams Street, Chicago.—50 cents.*

FLYING PIONEERS AT HAMMONDSPORT, NEW YORK, is an attractive illustrated booklet designed to show the part played by Hammondsport and the Finger Lakes region in developing aviation from a hobby to its present state of importance. The pioneer work of Glenn H. Curtiss, and various groups of his associates, is graphically presented. The epoch-making contributions of Samuel Pierpont Langley are described, leading up to some of the more recent achievements in international aviation. *Better Hammondsport Club, Hammondsport, New York.—Gratis.*

Building Construction

TRANSFORMATION — FROM AN OLD HOUSE TO A NEW HOME is a well-illustrated "before and after" explanation of adaptable methods of restoring and enhancing dilapidated old houses at small cost. *National Lumber Manufacturer's Association, 702 Transportation Building, Washington, D. C.—Gratis.*

FACTS ABOUT THE STRUCTURAL STEEL INDUSTRY gives some interesting historical facts about the fabricating industry, traces the historical development of steel and iron, lists a dozen advantages of structual steel, and provides informative comparisons of the world's great buildings and bridges. *American Institute of Steel Construction, Inc., 200 Madison Avenue, New York.—Gratis.*

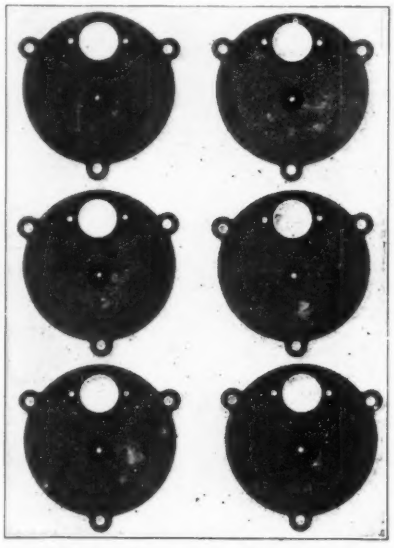
BUILDING IN THE ELECTRICAL AGE is a handsomely illustrated booklet showing the types of electrical equipment used in buildings of various kinds. Skyscrapers, all kinds of office buildings, hotels, theaters, public buildings, apartments, stores, hospitals, schools, churches, newspaper plants, and homes are represented. *Westinghouse Electric and Manufacturing Company, 195 Broadway, New York City.—Gratis.*

Electricity

THE WESTINGHOUSE LIGHTING INSTITUTE tells the story of the Institute recently established "to the end that Industry and Commerce may be benefited by the advantages that accrue from the adequate and proper use of lighting in their respective fields, and people in all walks of life may be afforded greater comfort, health, and happiness through a wider dissemination of knowledge respecting the possibilities and correct application of illumination to their needs." *Westinghouse Lighting Institute, Grand Central Palace, New York City.—Gratis.*

HOME MADE STATIC AND HOW TO AVOID IT, is devoted to the cause and cure of "man-made static," which causes much unnecessary interference with radio reception. Everyone who operates a radio set will find the booklet both interesting and helpful. *Radio Manufacturers Association, Inc., 11 West 42nd Street, New York City.—25 cents.*

X RAYS IN INDUSTRY is a booklet which shows the value of X rays for determining the internal structure of such objects as



Radiographic examination of small die castings, revealing shrinkage flaws, hard spots, and gas inclusions, detected with the X rays

castings, bearings, radio tubes, telephone poles, and an endless variety of manufactured products. The fundamentals of radiography are explained briefly and non-technically. *Eastman Kodak Company, Rochester, New York.—Gratis.*

Safety

FIRST AID MATERIALS, Catalog No. FA-1, will assist all who are interested in safety appliances and first-aid equipment, especially in mines, factories, and other industrial establishments. *Mine Safety Appliances Company, Pittsburgh, Pa.—Gratis.*

SAFETY IN THE AIR, by Harry F. Guggenheim, is a brief paper scanning the aviation industry from the standpoint of safety. Similar papers are SAFETY ON THE HIGH SEAS, by Joseph E. Sheedy, and SAFETY AND THE WORKER, by James J. Davis. The series was presented by radio through the coast-to-coast chain of stations associated with the National Broadcasting Company. *National Safety Council, 108 East Ohio Street, Chicago.—Gratis.*

LEAD, HEALTH PRACTISES PAMPHLET NO. 3, is a valuable compilation of practical information regarding lead poisoning in industry. The importance of adequate understanding of the problems of lead exposure is shown by the medical records. Lead is now used in 150 trades and is constantly finding new applications. Many employers and workmen have failed to appreciate the insidious character of lead poisoning. *National Safety Council, 108 East Ohio Street, Chicago.—Gratis.*

THE SKY'S THE LIMIT is a well-written argument against the smoke nuisance, showing that an effective means of clearing the atmosphere is by burning gas, coke, and other "smokeless" fuel. *American Gas Association, 420 Lexington Avenue, New York City.—Gratis.*

Miscellaneous

AGRICULTURE YEARBOOK FOR 1928 includes short articles regarding recent developments in agricultural science and practise, and non-technical descriptions of all aspects of farming from soil preparation to marketing. The book also contains the annual report of the Secretary of Agriculture, and the customary compilation of agricultural statistics. Charts, maps, special indexes, and cross references add to the book's value. *United States Government Printing Office, Washington, D. C.—$1.50.*

SECOND BULLETIN OF THE INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION, reports the progress made to date in extending and co-ordinating the activities for conserving the wild bird-life of the earth. The bulletin is a chronicle of the recent Geneva Conference, attended by representatives of the various national societies devoted to the preservation of birds. *T. Gilbert Pearson, Chairman, National Association of Audubon Societies, 1874 Broadway, New York City.—Gratis.*

RECENT ECONOMIC CHANGES IN THE UNITED STATES, is the title of the report of the President's Conference on Unemployment, which recently completed a nation-wide survey to appraise the changes that have taken place in economic conditions in the United States since the World War. An appendix contains an outline of the report. *United States Government Printing Office, Washington, D. C.—5 cents.*

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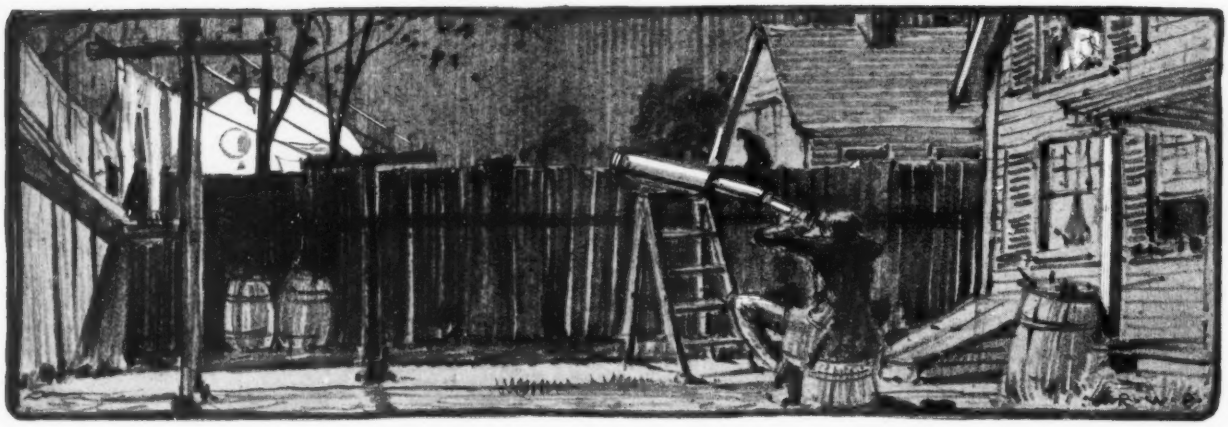
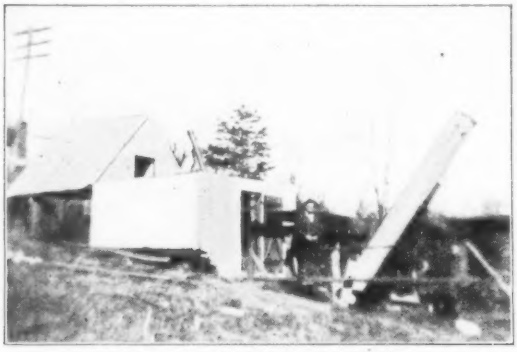


The Amateur Astronomer

G. W. NORVELL, a telegraph operator at Covesville, Virginia, has made a 16-inch telescope with a solid tube that looks like one of the large-caliber guns on a super-dreadnaught. In addition, he has made two 10-inch mirrors and the mounting for a 6½-inch refractor. The two



Mr. Norvell and his telescopes

pieces of armament show in the accompanying photograph. The observatory for the refractor has a sliding gantry roof, an easy type to construct.

"I am sending you," Mr. Norvell writes, "a snap shot of my 16-inch reflector. The mirror was made of inch and one half glass. I took my time and did not let the surface get scratched, nor did I have difficulty with sticking. I did have quite a time landing a good correction on the glass but I had previously made two 10-inch mirrors and this helped wonderfully.

"I ground the mirror to a focal ratio of 11 to 1. This is quite long, but it gives a fine flat field, and when seeing is good it is hard to beat. The glass shows no flexure but I would not advise anyone to attempt a larger mirror with such thin glass. Anyone who wishes to try a 16-inch will surely have to be careful, as it is altogether more of a job than a 10-inch.

"I can see with the telescope white objects, looking like foam, on the sun; also good markings on Mars; Jupiter's fine markings from pole to pole; and Saturn's rings and divisions.

"The tube is 16 feet in length and 19 inches in diameter. The mounting is made of pipe; the polar axis is 4-inch pipe turned in a lathe to fit a brass box. The whole outfit is set in concrete. It took 215 pounds of old babbit metal to provide a heavy enough counterweight.

"You will notice I have a sliding roof over my refractor, running on balls.

"I do not know what I shall try next, but am thinking of attempting a spectrohelioscope."

FRANK L. WATTS, Box 637, Silvis, Illinois, has made a Cassegrainian telescope. Mr. Watts writes as follows:

"Enclosed is a photo of my 6-inch Cassegrainian telescope. This is my first attempt at making one of this type. The small convex mirror gave me some little trouble in correcting but I succeeded in the end, so that the best of definition is had.

"I get nearly as good results with this as with my 9-inch Newtonian reflector, and fully as good as with my 6-inch refractor. Owing to the long focal length the image is better near the edge of the field than in either of these other telescopes.

"In correcting for figure I did all the testing with a 10-inch flat, and find this gives far better results than by the ordinary method.

"I have interested several parties in this work and expect to build a 16-inch. I have a well equipped shop and will be pleased to help anyone wishing to build a telescope.

"I wish to thank you very much for aiding me, through your literature."

BELOW we quote a fragment or two from a recent letter from Reverend W. F. A. Ellison, author of the original book "The Amateur's Telescope," most of which is now embodied in "Amateur Telescope Making." Last autumn the Telescope Editor spent a most interesting day with Ellison at the Armagh Observatory in Northern Ireland. A photograph of this delightful old place with its surrounding parks of yew trees and shrubs is reproduced in these columns. The Observatory was built about 1790 and is now used as a residence. It also houses a number of old telescopes and transits which are now curiosities. Carefully put away in a box was a neat brass reflector, about a 6-inch, used by King George III, who was an amateur astronomer. The two modern observatory domes do not show in the picture. One houses a 10-inch, the other an 18-inch, reflector; both of which are used by Ellison. He also maintains a government meteorological station.

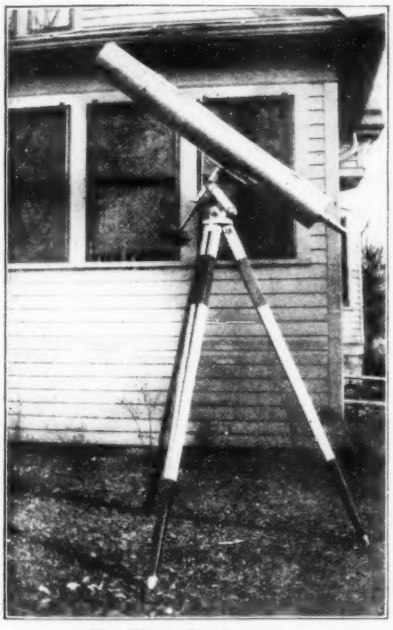
One corner of Ellison's workshop building, a thick-walled stone structure, is visible at the extreme right. As one might safely anticipate, this work room in which the superlative Ellison mirrors are made by hand, was utterly simple—no complicated apparatus, no "patent dingbats," no pretension. The testing stand was as plain as one which might be built to test a single mirror. Of course, an expert's main stock of "apparatus" is under his skull. Reverend Ellison stated that he has now completed 140 mirrors, instead of the 70 mentioned in A. T. M. (page 73).

To visualize this mentor of the amateurs the reader may think of a tall, large-framed,

Armagh Observatory in Northern Ireland

striking individual of about 50, with swarthy black beard, dressed in the cloth of the clergyman, with the leggings, the low broad hat and other habiliments of the protestant "Church of Ireland." He, it turned out, is also an expert organist, and his performance on the great electric organ of the Armagh Cathedral was equal in quality with his performances on optical surfaces.

Rev. Ellison writes: "I am afraid your people over there have gone ahead of my reach altogether. If I started the movement, I was like the small boy that rolled a stone down the mountain and started an avalanche. So, far from landing a lovely job like your Mr. Porter I am sometimes afraid 'The Amateur's Telescope' has knocked the bottom out of my market. Still, I am glad to think I have helped so many folks. Tell Mr. Porter, as well as the rest of



Mr. Watts' telescope

the brotherhood of 'C. P. R.' (that is, not Canadian Pacific Railway, but 'Carborundum, Pitch and Rouge') that I wish 'more power to their elbows,' and I hope they will not forget the fellow who set the ball rolling.

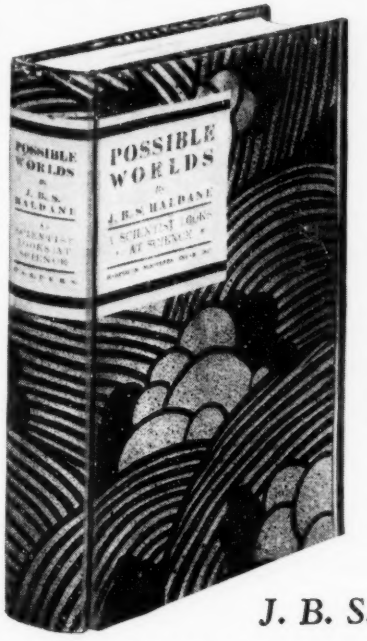
"The real difficulty about 16- and 21-inch jobs is in the mounting and using. I know from my experience with an 18 inch that observing with a 21 inch is no picnic." (Later we shall explain this.—*Ed.*)

RECENTLY several have asked why we did not pay more attention to observations and things actually done with the telescopes already in use by amateurs. One reason is that we lack the space to publish them in the magazine. We shall, then, confine ourselves in this department more to the mechanical end of the work and we suggest that descriptive observations be submitted to our esteemed contemporary, *Popular Astronomy* (Northfield, Minnesota). That journal has recently started a special department for amateur observers. These reports of such observations should be condensed as much as possible.

One type of "observation" which does

(*Please turn to page* 262)

Is One Year of Your Life Worth $2.50?



Bruce Gould, in the *New York Evening World*, says, "It is worth one year of the life of all but perhaps a thousand people in this country. By that we mean that the rest of us could well afford to die a year earlier in exchange for the privilege of sharing the mind of Haldane only in so far as it is revealed in this book. Whatever we would do with that year will not be as important as reading—"

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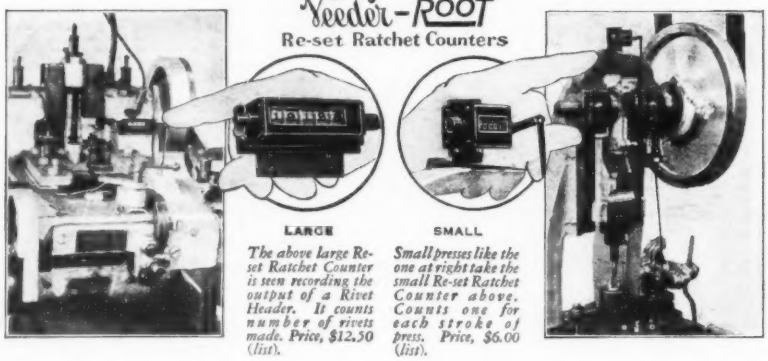

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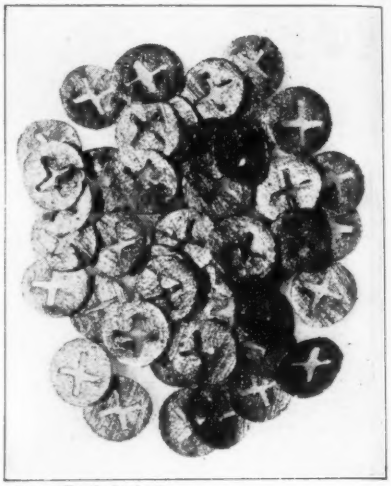
Chemistry in Industry

(*Continued from page* 254)

necessitated the use of substitutes. In this event sugars, such as cane sugar and glucose, were dissolved in the glycerin and nitrated with it and the sucrose and glucose nitrates thus produced, were found to depress the freezing point of the "nitroglycerin." Later polymerized glycerins, in which the residue of two or more molecules of glycerin had coalesced to form larger molecules, were dissolved in the glycerin and nitrated with it, the nitrated polyglycerins serving admirably to depress the freezing point of the nitroglycerin.



Courtesy Hercules Powder Co.

Not Chinese coins, but grains of smokeless powder, extensively used in building and construction work

The latest depressant used is ethylene glycol dinitrate. Its introduction was determined to an extent by economic reasons, but it serves well the purpose and possesses additional characteristics of value. The ethylene glycol, which is mixed with the glycerin before nitration, is synthesized from natural gas and there is every reason to believe that the available supply will prove abundant for many years.

New Protective Coating Has Rubber Base

A NEW protective coating marketed under the name of "Rubalt" has been placed on the market by Alfred Hague and Company of New York. This material is composed of rubber, bitumen, and benzol and is said to be highly resistant to mineral acids, alkalies, chlorine, ammonia, brine, and other chemical media. The coating is ordinarily black, although one grade is made in a number of colors. The colored grade is not in general as successful with powerful corrosive agents as the various grades of black material.

Smoke Encourages Pneumonia

THE pneumonia ratio in congested urban centers is in direct proportion to the smoke density, says Professor S. W. Parr of the University of Illinois and President of the American Chemical Society, who is making a careful study of the use and conservation of fuels in the United States. He states that:

"The more smoke, the more pneumonia;

the less smoke, the less pneumonia. The accentuation of the smoke evil in large industrial centers has set in motion various investigations looking to abatement. Sooner or later these studies lead back for a solution to the carbonization of coal and the use of smokeless fuel in some form. When gas reaches the stage of volume production, it will be the most powerful influence in ridding our cities of the smoke mask which now ruins our health and damages our property."

Fluorine Commercially Produced

MEMBERS of the American Electrochemical Society, attending a recent convention, were the first to hear of the startling research carried out at Cornell University by Professors Wilder D. Bancroft and Newton C. Jones on the production of the rare gas, fluorine, in commercial quantities of a thousand cubic feet at a time. Although fluorine has been made in very minute quantities in a few laboratories in years past, and has at those times excited the interest of the investigators, it has never been possible in the past to collect sufficient quantities of this interesting, yet very elusive, gas to allow the scientists to investigate thoroughly its characteristic properties.

Fluorine is not an uncommon element, and occurs in large quantities in various parts of the earth's crust, combined chiefly with calcium, as fluorspar. But to free the fluorine from its combination with other elements has been an extremely difficult feat, and it was not until about three years ago that Professor F. C. Mathers of the University of Indiana pointed out the way that has lead to the remarkable development and results of today. Due to the very specific nature of fluorine, it being the most active of all the elements, an entirely new chapter of chemistry has been opened. For example, the reaction of fluorine gas with benzene proceeds explosively, a result which is most surprising on the basis of the little information regarding the properties of the gas heretofore available.

Caustic Soda Made by Use of Fluorine

CAUSTIC soda, one of the most important commercial chemicals, is ordinarily made by an electrolytic process which is well established and efficient. German chemists, however, apparently refuse to believe that there is any chemical process which cannot be improved upon and have worked out a novel method for caustic soda manufacture which they believe to have commercial possibilities.

Briefly, the process involves the production of caustic soda from salt and calcium carbonate by the use of fluorine compounds, which are constantly regenerated. The steps are: (1) To an acid solution of sodium chloride, containing precipitated CaF_2 from a third manufacturing step, is added gaseous SiF_4 from the second step. The product is a firm sodium fluosilicate which is filtered out. (2) The fluosilicate is broken down at 700 degrees, Centigrade, to NaF and SiF_4, which is utilized in step one. (3) NaF is converted to caustic soda by addition of milk of lime, a further product being the CaF_2 used in step one.

The basic idea of the process dates to 1858, but with its numerous present improvements the promoters of the process claim that the only problem that remains now is that of efficient equipment.

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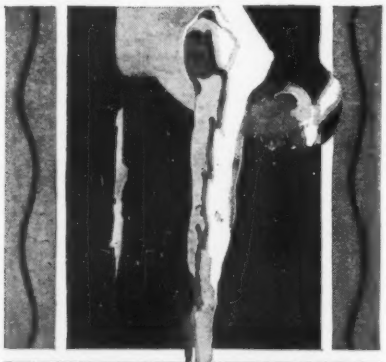

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The Amateur Astronomer

(*Continued from page 259*)

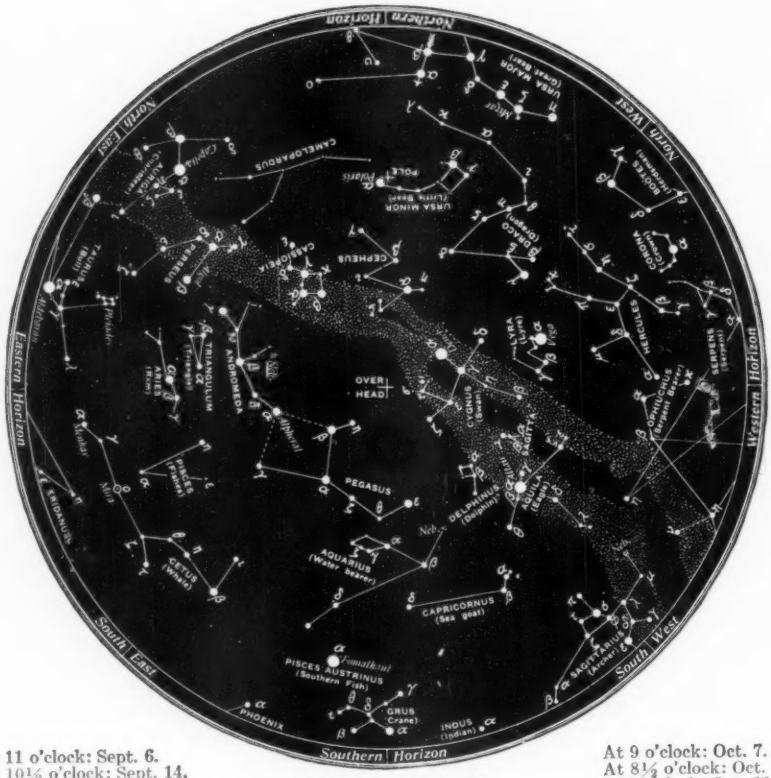
bear directly on mirror making—specifically on mirror figuring—is the matter of resolving power of a telescope, as determined by its ability to separate close double stars. A. R. Dunlop of New Westminster, British Columbia, suggests that all the amateurs send in brief statements of the closest double stars their telescopes will separate—a good idea, especially in view of the fact that one telescope maker, a noted professional, once stated to us that he had seen no amateur mirrors with really good figures. We believe he has not seen a representative lot. How can we convince him there are better ones?

Send in your best examples of double star dividing. For the theory of resolving power see Bell, "The Telescope."

IN the July number we broached the question of popularizing seismology, and asked interested readers to write to us. The response was not exactly overwhelming, but we did not expect seismology to make the same killing amateur telescope making did when we broached that subject in November, 1925. A well-known scientist has now sent us, for later publication, the description of a small seismograph of a special type which, to judge from the photographs and drawing, should give the constructor just enough worry to make him feel the job was worth while doing.—*A.G.I., Tel. Ed.*

The Heavens in September

By PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: Sept. 6.
At 10½ o'clock: Sept. 14.
At 10 o'clock: Sept. 21
At 9½ o'clock: Sept. 30.
At 9 o'clock: Oct. 7.
At 8½ o'clock: Oct. 15
At 8 o'clock: Oct. 22

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on September 6, etc.

NIGHT SKY: SEPTEMBER AND OCTOBER

MERCURY is an evening star but is not placed for northern observers, since he is south of the sun and therefore sets relatively early. At his greatest elongation on the 12th he sets at 7 P.M. and should be just visible in the twilight. Venus is a morning star in Cancer and Leo, rising between 2:30 and 3:30 A.M. Mars is an evening star low in the west and sets between 7 and 8 P.M. Jupiter is in quadrature east of the sun on the 8th and, being far north, rises at 10:30 P.M. After midnight he is conspicuous. Saturn is in quadrature east of the sun on the 17th and becomes an evening star. Being far south he sets at 10:30 P.M. Uranus is approaching opposition and is observable with the telescope after 10 P.M. Neptune is just past conjunction with the sun and is observable only at the end of the month.

The moon is new at 7 A.M. on the 3rd; in her first quarter at 6 P.M. on the 10th; full at the same hour on the 18th; and in her last quarter at 9 P.M. on the 25th. She is nearest the earth on the 27th, and farthest away on the 12th. She is near Neptune in the sky on the 2nd, Mercury and Mars on the 5th, Saturn on the 11th, Uranus on the 19th, Jupiter on the 24th, and Neptune and Venus together on the 30th.

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The Scientific American Digest

(*Continued from page* 247)

during which they work, is under 55 horsepower, the corresponding figure for Europe being about 400 horsepower. Any effect of broadcasting on weather would therefore be due to "sub-homeopathic doses" of less than one in a thousand million. Applying the same kind of arithmetic to the suburban home, one finds that to produce a year's rain for the tennis court by means of an electric kettle would cost 800 pounds (nearly 4000 dollars) or more, while the home's contribution to the power bill of the local broadcasting transmitter is an eighth of a penny a year.—*Discovery*, (London.)

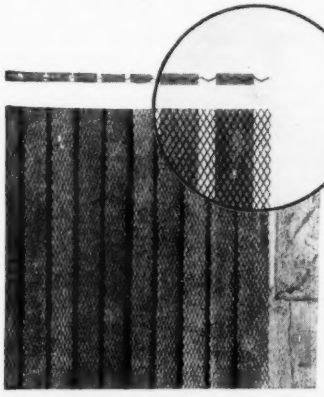
X Ray Detects Smuggled Diamonds

TO locate diamonds swallowed or concealed beneath the skin of those attempting to smuggle them out of the Union of South Africa, government authorities at Port Nolloth are installing an X-ray machine with which suspects can be searched.
—*Science Service.*

Fiber-Metal Plaster Laths

THE recent adoption by the Building Trades of the five-day schedule, comes as no surprise to those in the "know."

It is true, perhaps, that relatively few



Special fiber is pressed into sheets of expanded metal and the result is a sheet that typifies the common wood lath in form and use

of the mechanics, carpenters, plasterers, riveters, and other laborers appreciate *why* it has been possible to establish a five-day week. But builders, contractors, architects, and engineers have seen this movement coming for a long time past. It is the natural outcome of the never-slackening, onward march of progress, led by science and inventive genius.

One example of the progress which made possible reduction of working time is the first major improvement in the use of laths—a method dating to extremely ancient times—by the development of a new material to take the place of wood laths. And here again, as has so frequently been the case with other improvements, this one was extremely simple in conception.

In effect, the new lath, while made of fiber, typifies the common wood lath with the addition of a continuous connecting sheet of expanded metal. It might also be described as a rigid framework of expanded steel, impregnated with bands of pressed wood fiber to simulate wood laths.

The new material cuts labor costs, for

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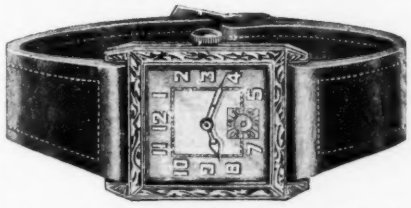
Vibration-proof!



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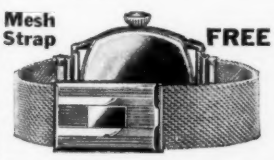

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More About the Robot

HAVING read the item in this department in our July 1929 issue concerning the robot, Mr. Wolf A. Lederer has very kindly submitted further information relative to the derivation of the word robot. A portion of his letter follows:

"In the province of Bosnia and The Hercegovina, the section of Jugo-Slavia I hail from, this word had another meaning too. For there it meant, if used as a verb: to robot, heavy physical labor which is not being paid—that is, there existed the old feudal system until 1918 and the 'knez,' (equivalent to the medieval serf) was required to do a certain amount of free labor for his master, the 'aga' or 'pasha.' This work frequently consisted in building roads and, in some sections, the men and women of several villages were required, each village furnishing a stated number, to perform this work, which was *not* paid for. These people were called the 'robotasi' (robotashy) and had to perform this labor so many days every year, or month, depending on the agreements. It was finally also extended to convict labor; also heavy labor without pay. The origin is from 'rob' meaning the slave."

Console Plays Symphonies in Light

WITH a recently developed apparatus which looks like a minature pipe organ console, symphonies of light without a single repetition of scene may be "played" for hours at a time. Then when the operator tires of composing light harmonies, a touch of a button starts a pre-arranged cycle of chromatic rhythms; an automatic roll similar to the player piano roll takes over the job and the operator is free to watch the machine bathe the setting in rainbows of ever-changing colors. The apparatus may be used in show windows, in ballrooms, in theaters, and as a dazzling fountain or a stately memorial.

This apparatus, which is called the Lumitone and is manufactured by Curtis Lighting, Inc., of Chicago, is a control device for mobile lighting which provides for the automatic or manual remote control of all circuits. The dimming of lighting circuits is accomplished without flicker and in exactly the order which has been pre-determined. When the automatic playing roll is used, various color effects can be planned and executed with certainty for several hours without repeating a single setting. Each dimmer is driven independently of any of the others and can be moved up or down, or the circuit can be turned on and off regardless of the condition or movement of other dimmers.

In the tracker bar over which the record roll passes there are four holes for each circuit. One of these turns on the current, one moves the dimmer up, one moves the dimmer down, and one turns the current off. As the paper roll passes these openings

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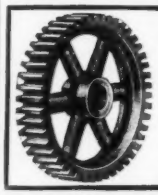

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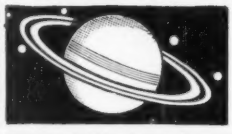

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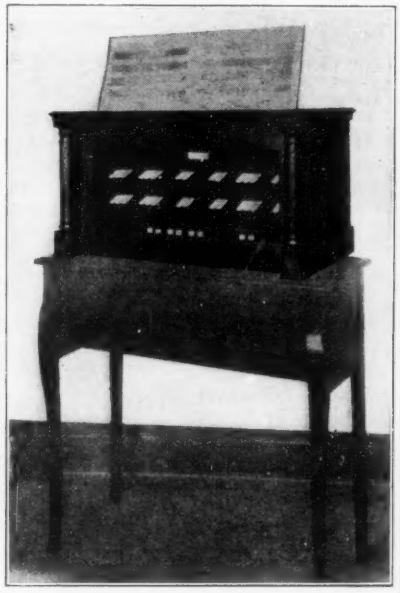
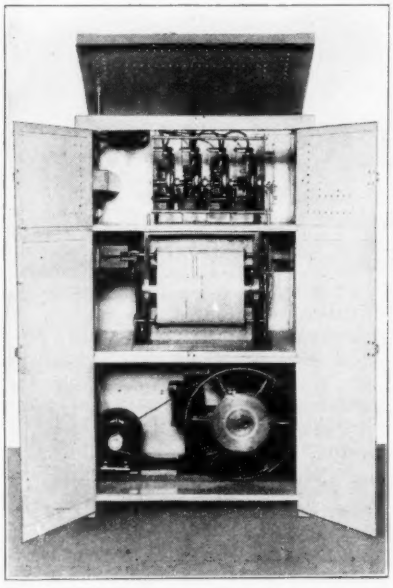
the functions of each are performed according to the pattern of the perforations. The entire mechanism functions through the use of electro-pneumatics.

The manual keyboard is divided into three main divisions: solo, accompaniment, and special effects. The solo section plays all of the colors which are directed toward



Above is shown the console by means of which veritable symphonies in light may be "played." Below is the interior mechanism of the apparatus showing the "music roll" control for the lights



the main feature of the display. The accompaniment section plays all the colors in the background. The background may be kept subdued as in a great solo, or may be brought up in a crashing crescendo as in a large chorus effect. The special effect buttons are imbedded in the shelf and are used only when something out of the ordinary is to be executed. The solo keys are in the upper bank and are usually played with the right hand while the accompaniment keys are in the lower bank and are usually played with the left hand.

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Commercial Property News

Facts and Notes of Interest to Inventors, Patentees, and Owners of Trademark Rights

Rear Admiral Awarded Damages in Torpedo Plane Patent Suit

DAMAGES amounting to 198,500 dollars for infringing the patent rights of Rear Admiral Bradley A. Fiske, retired, have been ordered in a judgment rendered against Rear Admiral William A. Moffett by the Supreme Court of the District of Columbia. It was understood by the court that Rear Admiral Moffett had authorized and ordered the manufacture and use of 397 torpedo planes, valued at 500 dollars each, infringing the patent rights of Rear Admiral Fiske who invented the torpedo plane in 1912.

The question was raised as to whether the government and its officials possess the right to use without compensation the patented inventions of individuals employed by the government. Justice Stafford, of the Supreme Court of the District of Columbia, held that, "the right of an officer in the Navy or the Army to take out a patent has been recognized by the Supreme Court of the United States, and is no longer open to question."

It may seem both improper and unfair for Rear Admiral Moffett, as an individual, to be the defendant in the case, but the court ruled that validity and infringement having been established, the plaintiff as owner of the patent had the right of action for damages.

"This right of action he had against the defendant as a wrongdoer, personally and individually, notwithstanding the fact that his acts of infringement were performed by him merely as an official of the United States and without profit to himself," in the opinion of Justice Stafford. Rear Admiral Moffett has appealed the judgment to the Court of Appeals of the District of Columbia.

Sleeve Valve Motor Held Different From Prior Patent

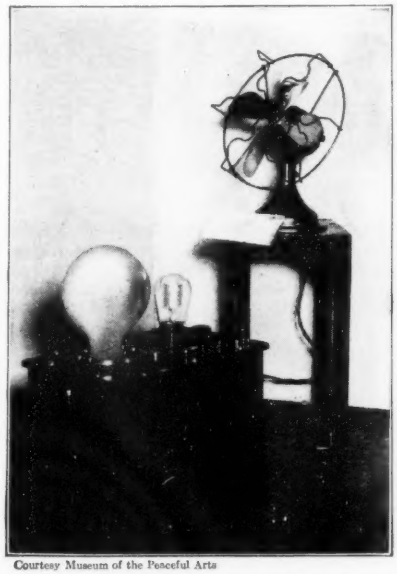
NO suggestion of a sleeve valve formed of reticulated steel was found in the prior patent for a recriprocating sleeve valve taken in connection with a car axle journal bearing made preferably of reticulated metal parts. This decision resulted in the grant of Patent 1718082 to Charles Schaeffer for an improved sleeve that slides against the cylinder wall of an internal combustion engine.

The Schaeffer valve is constructed of reticulated steel, and is coated both inside and outside with interconnected antifriction metal such as copper. According to the inventor, this construction gives greater strength than the sleeve valves of the usual type. Due to its design, the sleeve fits closer to the cylinder without gripping, reducing the oil consumption as well as assuring longer service before the valve wears out.

The application had been rejected by the Examiner, who was of the opinion that the Schaeffer sleeve valve was simply a combination without invention, utilizing the reciprocating sleeve valve shown by Miller, with the use of reticulated metal sheets as used by Sargent in a car axle journal bearing. The Examiner's rejection was reversed by the decision of the Board of Appeals.

Makers of "Just-as-Good" Parts for Automobiles Lose in Suit

AN order has been issued by the Circuit Court of Appeals for the Seventh District to restrain certain manufacturers of automobile hub caps from making and selling parts in unqualified imitation of those provided on Buick, Oakland, Chevrolet, and Pontiac cars. The decision was in favor of the General Motors Corporation, confirming the holding of a lower court that the owner of the trademark in question is exclusively entitled to market all replacement parts bearing that trademark. Of course that would not hinder anyone from making and selling articles like the original in size and shape, but the public has a right to know that replacement parts bearing the trademark of a well-known manufacturer are "genuine" and not merely "just-as-good."



Courtesy Museum of the Peaceful Arts

When one's hand is moved near the metal ball, electric circuits close, starting the fan, thus demonstrating the remarkable sensitivity of the "grid-glow" relay, shown on top of the cabinet next to the ball

Addition of Useless Step Irrelevant to Infringement

IN a recent suit for infringement of patent rights, the defendant contended that the adoption of an additional step in the process should defeat the charge of infringement. The case was an action in equity in the District Court for the Eastern District of New York, for an injunction to restrain the Greenport Sewerage Company from working a process for antisepticizing water and sewage, covered by a patent issued to Georg Ornstein and assigned to the Electro Bleaching Gas Company.

After the validity of the Ornstein patent had been confirmed, the court found that the added step used by the Greenport Sewerage Company was of no value to the process, according to the testimony of experts. A decree was issued in favor of the plaintiff, granting the injunction.

Who Does The Inventing?

TRACING the progress of civilization from the day when man, presumably, dropped from a tree with a fragment of his former home for a weapon with which to face the beasts of the jungle, William M. Grosvenor, in an article which recently appeared in *Chemical Markets*, discusses some rather significant points regarding the urge to invent and its result.

"Invention has gradually converted communicative grunts and growls into the power and melody of speech and song," Dr. Grosvenor believes. "Invention developed the notches on a stick and the scratches on tablets of baked clay into literature and libraries. Invention has turned the shelter of the hollow tree and the cave into the palatial home and the skyscraper. It has given us not only our languages, our weapons, and our houses, but also our transport on land, sea, and air; our money, banking, and exchange; our rapid communication by light, wire, and wireless; our thoughts, our cultures, and even our religions!" From the nature of this eulogy, one might suppose that Invention had died and was being buried.

But Dr. Grosvenor has another purpose. He points out that the progress of civilization was very slow until man added the word "reward" to the old blurb about "supply and demand." When the realization appeared that a demand and reward created a supply, "inventions became for the first time consciously the garnered and nurtured seeds of progress."

This leads to the astute observation that "the patent system, itself, is an invention for fostering invention." But the heart of the article by Dr. Grosvenor is contained in his comparison between the product of the pioneer inventor, working "on his own," and the inventions developed by research in the laboratories and shops of our large industrial corporations.

"Thirty years of observation and research in patent matters convince me that the proportion of *revolutionary* improvements, which is initiated by large corporations is relatively small. I have seen the lines of progress that were most promising for the public benefit, wholly neglected or positively forbidden just because they might revolutionize the industry. We have no right to expect a corporation to cut its own throat from purely eleemosynary

motives." (By the way, that word means *charitable*—Editor.) Dr. Grosvenor gives due credit to the big corporations for what he calls "development research" and improvements in organization, economies, enlargement, advertising, and merchandising. But when it comes to pioneering, he says, the story is very different.

"From Noah's Ark down the ages to Marconi and the Wrights, it has generally been the so-called 'crazy' fellow, who didn't know any better and was working on his own, who revolutionized affairs and opened up new horizons of progress by creating new industries and rendering old industries more or less obsolete. He had his own vision, made his own sacrifices to his own gods, and there was no man to say him nay; so he kept on trying until it happened. Railroads were absurd, steamboats were unsafe, explosives dangerous to use, wireless was a scientific curiosity, heavier-than-air machines were demonstratably impossible. Gasified motor fuel was a waste of volumetric efficiency, many a Bergius process was either not theoretically practicable or not practically worth while, et cetera. Had the authorities of the time had their own way, we would have had no Judaism, no Christianity, no United States of America. Freedom of individual initiative and security of desired recognition and reward if successful, are what both common sense and history teach us to be the essentials to big strides of progress."

A tabulation of the revolutionary inventions made since 1889, when large corporate investigation may be said to have started, shows that 12 out of the 72 outstanding inventions have been produced by corporation research. Of these inventions, a few that are typical are: high-speed steel, vat dies, ductile tungsten, oil cracking, Permalloy, and silica gel.

During the same period, independent inventors working "on their own," contributed such inventions as: monotype, case hardened steel, photogravure, motion-picture camera, dial telephone, calcium carbide, Deisel engine, carborundum, motion-picture projector, radio telegraph, electric train-control, electric automobile starter, submarine, safety razor, airplane, flotation process, radio crystal detector, Bakelite, electric precipitation, gyro-compass, and salvarsan.

Although not pointed out in Dr. Grosvenor's article, it is rather significant that inventions produced as a result of research fostered by large corporations are becoming a more important factor every year. For example, not more than seven out of 55 inventions of outstanding importance patented from 1890 to 1910 were the result of corporation research; but during the next twenty years, roughly, there were five out of 17 major inventions credited to corporation research. Apparently our large industrial organizations are profiting by history's great lesson, "He who does not advance falls behind."

Makers of "Castoria" Win Trademark Decision

"BABIES Cry For Castoria," according to the nationally-known advertisements of the Centaur Company. It isn't on record that old men cry for it, but many of them recall the name and what it signifies. Of course the patent for "Castoria" has expired, but the trademark continues to be a commonly known word with a definite meaning. Consequently the deliberate misuse of the word, to designate an entirely different preparation, is unfair to the maker of "Castoria," and confusing to the public. Wouldn't it confuse and discourage a baby, if he cried for "Castoria" and got shoe blacking or shaving soap?

"A plainer case of intentional and wrongful invasion of the plaintiff's rights could hardly be concieved," said the District Court for the Western District of Pennsylvania when the Centaur Company brought suit for infringement and unfair competition against E. Genish, et al. The defendant was accused of selling as "Castoria" a preparation of an entirely different nature than the "genuine" product.

It had been held previously, in the case of Centaur versus Heinsfurter, that the expiration of the patent to Samuel Pitcher dedicated the name "Castoria" to the public, the assumption being that the product sold under that name was the product of the Pitcher patent. Based on that assumption, it had been held that the name was public property, if two or more manufacturers were making and selling the product of the expired patent.

But the record in the present case shows conclusively that "Castoria" as manufactured by the plaintiff for over 50 years is not, and never was, the product of the expired Pitcher patent. A comparison of the three formulas shows that the defendant in the case against E. Genish was unquestionably selling something different from the product of the Pitcher patent and different from the well-known "Castoria" of the Centaur Company.

The court ruled that the dedication of the trademark to the public, with the expiration of the Pitcher patent, was not proved. The word "Castoria" was judged subject to exclusive appropriation as a trademark, being an arbitrary term used to designate origin. A decree was granted, restraining the defendant from further infringement and unfair competition.

"Doctor B. F. Davis" Wins Approval as Trademark

BECAUSE the words were arranged in a distinctive manner, the notation, "Doctor B. F. Davis," has been allowed registration as a trademark. The word "Doctor" is placed above the name "B. F. Davis," the largest letters being in the center, the other letters tapering toward each end, and the general outline being completed by the use of triangular dots at each end.

The examiner had refused registration on the ground that the notation, being but the name of an individual, cannot be registered as a trademark because not written, printed, impressed, or woven in some particular and distinctive manner. First Assistant Commissioner Kinnan ruled that the examiner was in error, and that the entire notation was set forth in an unusual way, and that it is proper to consider it printed in a particular or distinctive manner.

Inter-Industry Distribution

THE high cost of many commodities is attributable in no small measure to the high cost of distributing them. It has been estimated that the wastes in the distribution of goods to the consumer amount to eight billion dollars a year and ways and means to cut down that waste have been studied long and earnestly.

Not all the waste, however, is to be found between the manufacturer and the consumer. There are undoubtedly leaks between the producer of the raw material and the manufacturer, and this is a phase of industrial merchandising which apparently never has been studied. Realizing this, the Department of Commerce has rec-

Patents Recently Issued

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Pertaining to Aeronautics

COLLAPSIBLE GAS CONTAINER WITH INTERNAL BRACING—For airships of the lighter than air type, so constructed that the container may be quickly and easily inflated with a gas free from air, and will permit the container to be entirely collapsed when empty. Patent 1715829. Otto Geisler.

Chemical Processes

PROCESS OF MANUFACTURING YEAST—Which comprises chilling a yeast propagating wort, having a slight alkaline reaction, by forcing the cold gases and vapors from expanding liquefied carbon dioxide through said yeast wort until it shows a slight acid reaction. Patent 1718910. Lucien Lavedan.

Designs

DESIGN FOR TEXTILE FABRIC—The inventor has been granted three patents for ornamental designs, 78633, 78634, 78635. Joseph Kullmann.

DESIGN FOR A BABY CARRIAGE BODY—Patent 78630. Florence M. and William Karle.

DESIGN FOR A STOCKING—Patent 78639. Ruby Lefi.

DESIGN FOR A CATALOG COVER—Patent 78579. Marshall E. Yadon.

DESIGN FOR A TEXTILE FABRIC—Patent 78623. Dezso R. Grulich.

DESIGN FOR A DRESS—The inventor has been granted four patents for dress designs, 78767, 77768, 78769, and 78770. Dorothy Long.

DESIGN FOR A DISH OR SIMILAR ARTICLE—Patent 78746. William P. Graham.

DESIGN FOR A GLOVE OR THE LIKE—The inventor has been granted two patents for ornamental designs, 78836 and 78837. Wallace E. Meyer.

Electrical Devices

ELECTRIC WATER HEATER—A small compact unit which may be conveniently attached to any pipe line or faucet, and will serve to heat

ommended to Congress for 1930 a National Distribution Census. To ascertain the possibility of obtaining the data called for in that recommendation, the Department recently began a census of industrial purchases in Cleveland, that city being selected because of the diversity of its industries and the complete co-operation offered by the manufacturers and the Chamber of Commerce.

The data requested includes an itemization by value of the purchases of manufacturers, for the year 1927. The items are to be classified by their use into four groups: (1) Raw materials (products which have not passed through a process of manufacture); (2) semi-finished goods (materials other than raw materials purchased for further processing, or fabrication into the products manufactured by the institution being enumerated); (3) mill supplies (materials used in the general maintenance of the plant, exclusive of material used in the repairs to machinery and the conditioning of plant equipment); and (4) plant equipment (including repair and maintenance supplies for conditioning plant equipment).

Gorton James, Chief of the Division of Domestic Commerce, sums up the situation in a statement as follows: "The marked progress in recent years in the production of commodities has been based largely on information developed by research, trade associations, and the state and federal government agencies devoted to promoting the welfare of American industry and commerce. This information has revealed opportunities for eliminating waste of former trial and error methods, and has resulted in increased efficiency and lower business costs.

"We now have problems of distribution which, in a like manner, require adequate factual information to furnish a basis for attacking these problems more intelligently. The buyer is suffering from disproportionate sales expense which is reflected in increased cost of products. The seller has thought it necessary to work many markets that, if the facts were known, probably would not support half the outlay assigned to them."

Fish Balls and Fish Cakes

ARE fish balls animal food or vegetable food?

There is room for a difference of opinion there. The question is an important one, for upon the proper classification of the article depends the amount of duty an importer has to pay. Collectors of customs at different ports have been making their own individual interpretations and considerable discord has resulted. The Commissioner of Customs, E. W. Camp, has been trying to straighten it out.

Confusion arises, he finds, from articles which originally were vegetables but which have lost their identity as vegetables. Bean flour, pea flour, yam flour and soya bean flour were comparatively easy to solve; they are prepared vegetables. Now, however, we have a more complex article—a product not made directly from vegetables, but from vegetable products.

A close study of the law leads to a solution. In paragraph 769, potato flour is specifically provided for. Fish balls contain potato flour. Fish balls, therefore, from now on in every port of entry in the country shall pay the duty provided for potato flour—20 percent *ad valorem*.

water flowing therefrom, the water itself acting as a conductor and resistant for the current which heats it. Patent 1717308. Vincenzo Boschetti.

ELECTRIC-LIGHT FIXTURE—Having a front reflector to hide lamps, and to throw rays of light on rear reflectors laterally and indirectly forwardly, and intermediate reflectors converging outwardly, and lamps at the outer sides behind the front reflectors, diffusing the light rays upwardly and downwardly. The inventor has been granted two patents on ornamental fixtures. Patents 1718154 and 1718155. William Klehr.

Of Interest to Farmers

GRAIN VENTILATOR—A combined ventilator and drier, consisting of an elongated tubular member containing a body of moisture absorbing material, and central and lateral air passages which may be imbedded in a storage bin to prevent grain from molding, etc. Patent 1715256. John Stroble.

MILKING MACHINE—Having a pulsator with automatic means for relieving the vacuum and admitting air under atmospheric pressure to the cow's udder, thereby simulating calf milking, the pulsator movements being noiseless in operation do not disturb nervous cows. Patent 1715720. Warren A. Shippert.

POWER LIFT FOR TRACTOR PLOWS—An arrangement which utilizes part of the power of the tractor engine in lifting a plow carried and driven by the tractor from operative or working position to an inoperative or suspended position upon the tractor frame. Patent 1717209. Levi C. Hester.

IRRIGATION FURROW-FORMING DEVICE—For cutting one or more trenches in a field or orchard for conveying irrigating water, having means for facilitating the adjustment of the cutting tools vertically to provide for a furrow of required depth. Patent 1716704. Thomas Mansfield.

Of General Interest

FASTENING DEVICE—A button-type fastener having a recess therein for receiving a fold of securing fabric, and a pin-type fastening element extending through the fabric in the recess to form a fastening means. Patent 1715258. Othar S. Tonn.

PROCESS OF AGING CALCINED GYPSUM—Which comprises the direct application of moisture, in a fine spray form, at the rate of from twelve to fifteen pounds to the ton of calcined gypsum per minute, for five to six minutes, while agitating the gypsum. Patent 1713879. Samuel G. McAnally.

SAFETY DEPOSIT RECEPTACLE—A box one side of which is provided with means whereby the receptacle may be securely attached to a wall bracket as used in railway cars, so that a traveler may safely protect his valuables. Patent 1714236. Edward S. Peer.

ADJUSTABLE STAND—For rivet cutters and the like, having a plurality of cutter rests and means pivotally connected with one of said rests for adjusting it vertically to vary the cutting angle of the tool. Patent 1715260. Peter Weber.

COMB—Having longitudinal passages through which a cord may be run, adapted for the drying the hair by absorbing moisture when the hair is combed, and also for applying oil or a tonic to the hair. Patent 17310 (Reissue) Harry H. Hutchings.

BOOKSTAND—In which a number of binders are mounted to conveniently hold books such as telephone directories and the like, and enable any book to be moved to reading position without detaching the book from the binder. Patent 1715233. Walter E. Haskin.

The decision would seem to be in line with the ones classifying salted watermelon seeds as nuts or a barrel of live snails as wild animals. You can't stump a customs collector.

Patent Examiner Hutchinson Completes 62nd Year in Service

WINNING the commendation of Secretary of Commerce Robert P. Lamont, as well as the cordial congratulations of his colleagues, Mr. William T. Hutchinson recently completed his sixty-second year in the employ of the United States Patent Office in Washington. Secretary Lamont's letter said:

"My dear Mr. Hutchinson: The Commissioner of Patents has just informed me that you are today completing your sixty-second year in the Government service and that you have charge of the applications for patents on such important inventions as time-locks for bank vaults, combination locks, et cetera.

"This is indeed a remarkable service, and I wish to felicitate you upon your long career of work well done. The Commissioner of Patents assures me that your knowledge of the complicated inventions under your charge and the manner in which you perform your work are particularly worthy of commendation."

Coming shortly after the Patent Office had been criticised as "a kindergarten for patent attorneys," this evidence of long service is of particular interest. It has been suggested that in too many cases young men become patent examiners, learn the intricate details of Patent Office procedure, and then when they become competent to serve in their new capacities, resign to take more lucrative positions with law firms.

In an editorial comment which appeared recently in *Industrial and Engineering Chemistry*, a startling but rather interesting remedy for such a situation was suggested. The contributor was directing his suggestion toward the chemical industry, but it may interest those in other industries.

"Don't think I'm criticizing the Patent Office. I don't blame the youngster who quits in order to better himself financially, nor the new examiner who is conscientiously trying to do a highly technical job with which he is not yet familiar.

"I'm only cursing our governmental system that saves a hundred dollars in patent examiners' salaries at a cost of thousands of dollars to industry in general, and I'm proposing in good faith that we, who have to pay the fees of patent attorneys, endow the Patent Office—we can well afford to—so that examiners will be paid enough to make the office something more than a training school for ambitious young men."

The suggestion that industry "endow the Patent Office" is not so radical as one might suppose, although there is little possibility that the United States Government would openly admit its incompetence to deal with any problem so vital to industrial and individual prosperity. Several of the other Bureaus of the Department of Commerce are practically "endowed" by specialized industries, and it may be that within a few years patent cases will be tried by technically trained judges, in a special patent court. But we do not anticipate any serious attempt to endow the Patent Office.

ELEVATOR SADDLE—Or sill, for the guidance of elevator doors, comprising a plurality of interlocking longitudinal sections with any desired number of grooves, always coupled by an arrangement of flanges. Patent 1715188. John Bullock and Lauritz U. Lacour.

DEVICE FOR FORMING BRAIDLIKE DECORATIONS—With means for receiving a plastic substance, such as sugar paste, plaster or the like, whereby a twirling motion is imparted as the substance is forced out, thus presenting a braidlike form. Patent 1714234. John A. Ost.

ORNAMENTAL BUILDING—A structure of conical form, having doors and windows near its base, and depicting an edible ice cream cone, with means for illuminating the exterior by projected lights to harmonize with the cone and colors of the ice cream. Patent 1713050. George H. Natzel and Frank E. Jackson.

SPRING ACTION FOR FIREARM HAMMERS—Capable of application to all types of firearms, when applied to automatic pistols, dispenses with the comparatively complicated spring action embodied in the grip, and in the heavier types permits the grip to be reduced in size. Patent 1711874. Archibald R. Brinkerhoff.

WINDOW CLEANER—For cleaning one surface of a window at a time, and having a special clamping means for fastening the pads, or cleaning elements, on a single staff, by a bail and coiled springs. Patent 1716171. Kenji Horihata.

HOUSEHOLD BIN—A tiltable bin having hinged connection with a fixed structure, such as a cabinet, and held to prevent the bin from dropping suddenly when opened or closed, adapted for the storage of coal or other materials. Patent 1716242. Theodore Ritsche.

FOLDING DISH RACK—Comprising a central portion having corrugations for receiving the dishes, upright ends pivotally secured to the central portion, and locking means for the uprights, the device when collapsed occupies but little space. Patent 1714629. Charles F. Rodin.

REFILLABLE SHAVING BRUSH—Of a sanitary nature, wherein the bristle tuft is comparatively inexpensive, and may be inserted in a handle, secured against rotary movement, used once and discarded. Patent 1716211. Juan A. Cuevas.

PROTECTIVE DEVICE—A marker adapted to be secured to an article or goods, and which cannot be tampered with, without leaving the device in a condition indicating that a fraudulent attempt has been made to substitute the goods. Patent 1716248. William A. Sonen.

VENTILATOR—A cowl formation adapted to be placed on top of a ventilating pipe, so that air passing in a horizontal direction will produce a rarefaction, and thereby draw gaséous matter upwardly and force the same to a discharge point. Patent 1717268. Louis J. Sheperd.

HANDLE CONNECTION FOR HAND BAGS AND THE LIKE—Especially designed for women's hand bags, pocketbooks or the like, which in addition to being attractive in appearance is strong and durable, simple in construction and economical to produce. Patent 1717295. Charles Wolf.

COOKER—Wherein food products, necessary in vending hot sandwiches, may be conveniently cooked and retained in a heated and palatable condition by conducting heat and moisture to the bread or rolls to soften and freshen the same. Patent 1717296. Clair G. Wright.

ACOUSTICAL DEVICE—Comprising a sound sensitive diaphragm and a dentiphone arm for receiving vibrations, with mouthpiece adapted to be held between the teeth, for enabling deaf persons, or persons hard of hearing, to hear through the teeth. Patent 1717202. John W. Gonce.

LENS-FITTING ATTACHMENT—For making a test of the lenses prescribed, in the particular frame which has been selected, and properly adjusted to the head, and for pupillary distance, instead of in what is generally known as a "trial frame." Patent 1717224. John L. King.

ARRANGEMENT FOR COOLING LIQUIDS OR FLUIDS — Which consists in passing the liquid by centrifugal force, and in thin layers, along the inner walls of rotating cylinders, which are formed of heat-conducting material, the outer walls being subjected to a cooling medium. Patent 1717237. Herbert Mager.

PERMANENT-WAVING CABINET—Designed for use by hairdressers, a cabinet mounted on casters and easily movable, for separately supporting in a conveniently accessible manner the various articles required in carrying out the waving operation without the services of an assistant. Patent 1717217. John L. Izan.

PORTABLE LIGHTER—Usually referred to as "cigar lighters," so constructed that there is little or no liability of an accidental operation while carried in the pocket, but may be easily operated by one hand. Patent 1717205. David W. Greene.

RING—Presenting outwardly substantially the same appearance as an ordinary ring, but wherein a book structure is presented having a series of leaves capable of receiving pictures, or preserving mementos, or records of special interest. Patent 1718113. Philip Cohen and Morris Rossein.

MOP—While capable of a wide range of usefulness, it is particularly intended for heavy duty, such as the spreading of tar in roofing work, it is so constructed that a worn head may be easily replaced. Patent 1718137. James H. Griffin.

SIGN-CASING CONSTRUCTION—Suitable for producing illuminated effects, whereby panels may be quickly and easily set in place or removed, and held in place without the use of fastening elements such as pins or screws. Patent 1718114. Charles J. Cornell.

SINK PAD—Formed of rubber or other waterproof material, adapted to be positioned between two separate kitchen devices, such as adjacent sinks and wash-tubs, to prevent water dropping therebetween, the water draining into either device. Patent 1718126. Jane Elovson.

VALVE—A forged valve, substantially the same size and weight as a similar cast value, where the physical properties of the forging and casting are the same, the valve being readily, convertible from a screw to a flange type. Patent 1717859. Robert H. Thorne.

FOOD CONTAINER—Particularly adapted for carrying luncheon, having a plurality of compartments separated by heat insulating walls, and the exterior being insulated, the box is neat in appearance and may be conveniently carried. Patent 1716367. Frank M. Clayton.

BOX—Adapted to be constructed from a cardboard blank or similar material, in which the sides are held together without nails, a reinforcing strip surrounding the upper edge of the box to strengthen the same. Patent 1716757. Alfred H. Beyer.

PORTABLE LIGHTER — Of the cigar and cigarette lighting type, which may be conveniently carried in the pocket, in which the mechanical parts are not liable to get out of order, and worn or injured parts may be readily replaced. Patent 1718902. David W. Greene.

ROLLED SHEET GLASS—Which has all of the translucent qualities of ordinary frosted or stippled glass, yet may embody various distinctive and sharply defined designs simulating panelling, the grooves being of V-shape in cross section, and relatively deep. Patent 1718824. Clement Jungers.

Hardware and Tools

TOOL—An expansible grinding tool for grinding or honing the cylinders of engines such as automobiles or the like, wherein the grinding elements are automatically expanded to the proper degree during the operation. Patent 1725255. Henry Strand and Byron de K. Jackson.

OIL-WATER AND AIR SEPARATOR—Adapted for use with pneumatic tools, such as riveters or hammers, and air brushes, whereby the moisture or oil is brought into contact with wire gauze and separated from the air, without interrupting the normal operation of the tool. Patent 1714825. Emil H. Stephan.

WRENCH—Having the dual properties of a pipe wrench and a nut wrench and quickly adjustable means for the jaws in either use, the handle and jaws acting as a compound lever to cause the jaws to grip any object. Patent 1713038. Amos K. Ersland.

LIFT—In the form of a rod with a metal cap and hook at the top, and a transverse bar intermediate its ends, which may be readily employed in removing or placing suitcases or traveling bags upon a shelf. Patent 1716232. Hymen Kantor.

BAND-SAW SHARPENER—Which is applicable to all standard makes of machines, may be readily adjusted to coincide with the angularity of the saw teeth, and will eliminate the necessity of removing the saw from the machine. Patent 1717206. William Grosskopf.

WELL FISHING TOOL—Embodying a plurality of various sized bells or sockets, any one of which may be employed in fishing for broken bits or other working tools, according to the diameter of the well. Patent 1717300. Vio A. Asplund.

PIPE OR ROD CLAMP—A clamp having jaws which may be quickly applied to or removed from the polish rod of an oil well rig, or other similar object, and when applied will positively grip and support the rod. Patent 1718072. Oscar A. Quarnstrom.

CAN OPENER — Having a spring-pressed pivotally mounted knife adapted to cut the top from the can when the can is revolved by a manually operated wheel, the grip being automatically increased in proportion to the required cutting power. Patent 1718125. Henry J. Edlund.

OFFSET BORING HEAD—A construction particularly adapted to metal-working, having an adjustable offset bearing head, whereby the boring or re-boring of holes from practically the smallest to the largest diameter may be accomplished by the same head. Patent 1718089. Edgar J. Tesoroni.

SCISSORS—In which springs are used which automatically prevent looseness, maintaining a continuous inward pressure on the blades, at a point slightly in advance of the screw fulcrum, and rendering the blades self-sharpening. Patent 1718907. Howell Jordan.

FASTENING MEANS FOR HAMMERS AND THE LIKE—Having toothed end spring pauls, adjustable to accommodate handles of different types, and for permanently securing the head on the handle, also to permit tightening in the event of wear after long use. Patent 1716605. Stanley J. Shepard.

Heating and Lighting

OIL BURNER—For use in domestic heat furnaces, or other places, wherein steam-producing containers are associated with the burner structure for mixing oil and steam with air thus securing a maximum of efficiency for the fuel used. Patent 1715205. Frank X. Mantsion.

FLUID DISTRIBUTOR—For distributing gas in a furnace or oven used for baking purposes, whereby the burners may be regulated to supply flames at different heights at the respective ends, or the gas may be supplied evenly throughout. Patent 1715248. Lloyd H. V. Reynolds and William B. Ensign.

LIQUID HEATER—In which hot water may be stored for use when required, a thermostat being associated therewith by which the electric heating current is controlled without either supervision or aid, and a special means being provided for opening the electric circuit should the current be turned on while the tank is dry. The inventor has been granted two patents, 1718865 and 1718866. Barnett W. Macy.

Machines and Mechanical Devices

DATA-SHEET FOR COMPUTING MACHINES AND THE LIKE—Which will effectively support a data sheet in position, and easily release the same therefrom, and will allow for the employment of a relatively large sheet, so that a wide range of computations may be displayed. Patent 1715259. Oliver F. Vose.

METHOD OF EXTRACTING CANDELILLA WAX—Which comprises a crushing and tearing of the plant whereby the wax and non-waxy matter is finely divided and separated from the fibers and screened, instead of carrying the whole bulk of the plant into the vat. Patent 1715194. Jose T. Garcia.

METHOD OF PRODUCING MOTION PICTURES—In which drawn cartoons, industrial subjects or the like, are combined and properly coordinated with photographically produced scenes of motion pictures, requiring a minimum number of steps and a minimum number of drawings. Patent 1715230. William A. Gilmartin.

CONTINUOUS-SETTLING DEVICE—For settling sedimentary matters from liquids, particularly adapted for use in the paper or sugar making industries, where comparatively large volumes of liquid are to be treated, to have all or most of the solid matter precipitated. Patent 1716228. James Q. Horne.

LUBRICATOR—A manually operable lubricator having a plurality of pumps adapted to be successively operated for supplying lubricant to various moving parts, and in proportions necessary to effect sufficient lubrication at all times. Patent 1716252. Samuel T. Voll.

FOLDING CYLINDER FOR PRINTING PRESSES—A construction wherein, by the addition of certain parts to an old cylinder, two sections of a newspaper may be folded together accurately at high speed and without danger of tearing the sheets of paper. Patent 1717257. George Rasmussen.

COMBINATION WASHER AND STERILIZER—A single manually operated apparatus for successively washing, rinsing and sterilizing dishes or other articles, and means for holding the cover of the machine closed during the time that these operations are being performed. Patent 1717229. Paul F. Kraeft.

DISPLAY DEVICE—For displaying articles to attract attention in the show window of a store, whereby the articles are moved to view and retained in such position periodically, the operation being intermittent. Patent 1717246. Albert Perling.

PERFORATING DEVICE—Which can be permanently secured to a printing machine without in any way affecting the operation of the machine, and so related to the rest of the machine that perforation takes place only when desired. Patent 1718164. Robert B. Magune.

Cotton Gin—In which spaced disks are provided with teeth on the opposite faces cooperating with either seed deflecting bars or tapered roller, and deflecting plates whereby the seeds and foreign matter of any size are discharged readily while the lint is removed by suction applied directly between the toothed disks. The inventor has been granted two patents, 1717356 and 1717436. Cary S. Cox.

COMBINED ADVERTISING AND STATION-INDICATING DEVICE—Which may be disposed within a car to automatically display a multiplicity of advertisements one at a time, and will move the name of the next station into observed position when the conductor presses a button. Patent 1716723. John A. and Clarence M. Greer.

AIR-COOLING DEVICE—Whereby the air in a room is cooled by the evaporation of a liquid, preferably water, and a forced draft is provided to increase the rate of evaporation, and drive the cooled air through pipes. Patent 1715753. Roland Hardy.

ROTARY GRINDING MILL—A shell which is elliptical in cross section, revolves on a common axis, and is partially filled with balls or rods so arranged that all the balls or rods will continuously move during the operation of the shell. Patent 1718552. William H. Fluker.

TRANSMISSION MECHANISM—Having ratchet and pawl elements, the pawls being in actual engagement only during the driving strokes, being moved out of engagement during the idle strokes, thus prolonging the life of the pawls, and eliminating undesirable noise. Patent 1716548. Jules Habrie.

SHAFT COUPLING—By which the vertical shafts of a rotary pump may be connected, and any required adjustment, as to length to allow of the adaptation of the shaft to a particular mechanism, may be readily accomplished. Patent 1716593. Earl Martin.

Medical and Surgical Devices

SURGICAL INSTRUMENTS—Whereby electricity is employed to destroy the tissue, as in the removal of tonsils, but in its association with a source of current, excluded from passing through the patient's body, the sole application being to the tonsil. Patent 1714220. Sutten H. Groff.

MEDICINE DROPPER—Having means for preventing fluid sucked up into the tube from being drawn into the rubber bulb, thus giving a longer life to the bulb which is not subjected to medical action. Patent 1713937. Charles G. Wheeland.

SYRINGE—In which one end is submerged in liquid in a basin, and firmly maintained at the bottom by a suction cup, the tube producing a siphoning action, and a bulb manually operated forcing the liquid through a nozzle. Patent 1716539. Louis B. de Spain.

Prime Movers and Their Accessories

GAS TIMER FOR ENGINES—Adapted to be inserted within the usual spark plug opening in a cylinder head of an engine for determining the position of the piston during the firing stroke and when the compressed gases are to be ignited. Patent 1715223. Reiff E. Christ.

WATER-CIRCULATION PREHEATING SYSTEM FOR INTERNAL-COMBUSTION ENGINES—An electric heater disposed between the radiator and the motor and adapted to heat water coming from the motor and cause the hot water to circulate through the motor without interfering with the water in the radiator. Patent 1716715. William B. Whelan.

ROTARY ENGINE—Having radially projectable blade members with which a novel means is employed for preventing centrifugal forces from causing undue frictional engagement with the adjacent stator walls, and means for cooling the valves to prevent warpage. Patent 1717610. John H. McCarthy.

INTERNAL - COMBUSTION ENGINE — Having telescoping pistons with means for compressing and firing an explosive mixture between them, whereby the pistons are forced in opposite directions so that at each explosion direct power is applied at opposite points on the crank shaft. Patent 1718116. James H. Crary.

MOTOR WITH SLEEVE VALVE—An internal combustion engine of the sleeve valve type, having a steel sleeve valve coated with metal adapted to reduce friction on all surfaces liable to rub against steel surfaces such as the walls or the piston. Patent 1718082. Charles Schaeffer.

OIL PURIFIER AND GAS SEPARATOR FOR INTERNAL-COMBUSTION ENGINES — Which will serve to subject the crank case oil to a continuous process of filtration and purification, and will separate gasoline from the crank case oil by a continuous process of recirculation and distillation. Patent 1718800. John G. Rea.

Railways and Their Accessories

RAILWAY TIE—A reinforced concrete tie formed of two blocks one positioned beneath each rail, with means for maintaining the blocks in spaced relation, the blocks being tapered toward their ends that they may be securely anchored against endwise displacement. Patent 1718098. Wallace C. Yeomans.

RAILROAD JOINT—For abutting rails, the joint being so constructed that weight passing over it is transferred from one rail to the other smoothly, there being no interruption in support, or flattening of the abutting ends of the rail. Patent 1715837. Charles A. Hunt.

Pertaining to Recreation

AMUSEMENT APPARATUS—Designed to simulate a race track, which is traversed by objects, in the form of horses or vehicles, the movements of which are brought about by persons competing, to the end that one with greatest skill will win. Patent 1716235. William F. Manning.

AMUSEMENT APPARATUS—An elevated horizontal support, having a passenger carrying mechanism embodying a plurality of swinging or oscillatory beams equipped with passenger carrying seats, and wherein the beams are actuated continuously by a common drive. Patent 1718167. Philip S. McLaughlin.

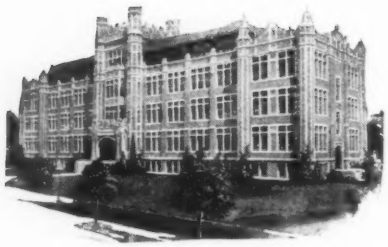
TOY BALLOON—Having a stabilizing member arranged to keep the balloon in its course, and to prevent it rolling or turning about its axis when flown as a kite or serving as an advertising medium. Patent 1718508. Leland C. White.

Pertaining to Vehicles

JACKING ATTACHMENT—Which will permit the application of a jack to the frame of a motor vehicle, in the rear of the wheels, the movement carrying the axle so that it will be lifted to the same height as the frame. Patent 1715790. Fred Schildman.

AUTOMOBILE ASH TRAY—Having means associated therewith for fastening the same to the door of a vehicle, the ashes and cigarette stubs, etc., being deposited through a suitable yielding cover and through a conduit to the open road. Patent 1715773. Raymond Morales.

MOTOR VEHICLE TOP—Of conventional "aerofoil" type, which acts as a wind shield, to deflect a portion of the air over the upper surface of open cars, thereby giving an unobstructed view, a glass wind shield being optional. Patent 1717515. Grant Linton.



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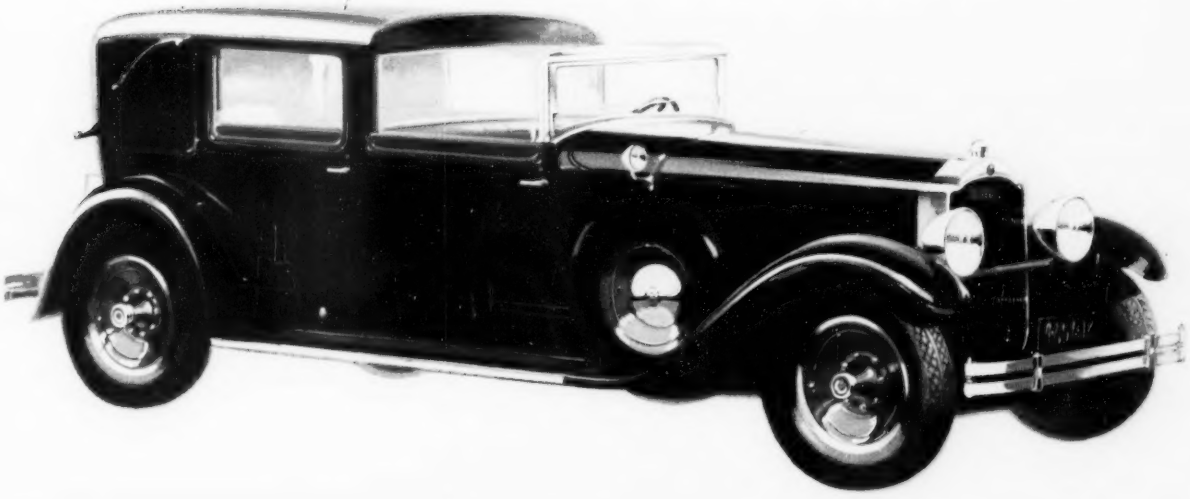

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